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Water Plant Optimization Study

CORNWALL WATER TREATMENT PLANT

December 1990

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Water Plant Optimization Study

Cornwall
Water Treatment Plant

Project No. 7-2037

December 1990

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Please note that some of the recommendations contained in this report may have already been completed at time of publication. For more information, please contact the local municipality, or the Water Resources Branch of the Ministry of the Environment.

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WATER PLANT OPTIMIZATION STUDY
CORNWALL WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization Study (WPOS) is to document and review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on the removal of particulate materials and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

A Supervisory Control and Data Acquisition System (SCADA) has been proposed for the Cornwall Water Treatment Plant. The proposed system should improve data collection, process control, and general efficiency in plant operation.

The Cornwall plant draws water from Lake St. Lawrence, which generally experiences very good and fairly consistent raw water quality. Overall, the operation of the Cornwall plant is quite good. There have been periods when alum has not been added to the water, and the treated water turbidity has occasionally exceeded 1.0 FTU.

In an effort to optimize particulate removal and disinfection at the Cornwall Plant, the following are suggested:

PHYSICAL IMPROVEMENTS

- Install filter effluent turbidimeters, to continuously monitor the four filter effluent turbidities.

STUDIES

- Conduct laboratory and plant scale testing to evaluate the merits of flash mixing.
- Continue to study the use of coagulant aids.

STUDIES (cont'd)

- Conduct plant scale testing on the effects of flowrate on the flocculation tank performance.
- Conduct testing to evaluate the relative performances of the filters.
- Conduct plant scale testing to evaluate the effect of lower filtration rates on filter effluent quality.
- Evaluate the flow ranges of the filtered water venturi meters.

OTHER RECOMMENDATIONS

- Add a coagulant continuously.
- Characterize and measure the depths of the filter media.
- Test the treated water for fecal coliforms and fecal streptococcus on a regular basis.
- The Ministry of the Environment should develop a surrogate measurement for chlorinated by-products for use in water plants in Ontario.

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TERMS OF REFERENCE

WATER PLANT OPTIMIZATION STUDY
CORNWALL WATER TREATMENT PLANT

INTRODUCTION AND TERMS OF REFERENCE

The Ontario Ministry of the Environment has instituted a Drinking Water Surveillance Program, consisting of a continuously updated data base of water quality information on Ontario water treatment plants. In connection with the surveillance program, a specific plant investigation and process evaluation study is desired for each plant entering the program. The study is to document and review the present operating conditions, and determine an optimum treatment strategy for particulate removal and disinfection at the plant.

The terms of reference for this Water Plant Optimization Study has been prepared by the Ministry, and has evolved during the period of this study. So as to make this report similar to later reports, we have included some of the items which are requested in the newer terms of reference. The most recent terms of reference is included at the back of the report, following the appendices. This optimization study has been conducted in accordance with the terms of reference and information package.

The Cornwall Plant provides the water supply and distribution system for the City of Cornwall. This optimization study provides a detailed examination of three years of daily and monthly plant operating data, a description of the facilities in place at the plant and their operation, and recommendations which could improve the particulate removal and disinfection performance of the plant.

SECTION A

RAW WATER SOURCE

SECTION A
RAW WATER SOURCE

A.1 General Quality

The Cornwall WTP draws water from Lake St. Lawrence. The raw water quality is very good and is relatively constant throughout the year.

Lake St. Lawrence water is low in turbidity, colour, and organic content and is, therefore, an ideal raw water source.

Some industrial development is located several kilometers upstream of the water plant. There exists a potential for contaminants to appear in the raw water, such as acids, but none have been detected to date.

The Cornwall Water Treatment Plant security measures consist of keeping all doors and windows locked. Only one side door is left open during working hours. Should a spill or other security event occur, the operators would call the plant superintendent for further instruction. The plant superintendent would close the raw water valves.

In the years 1983 - 1986, the general raw water quality parameters varied as follows:

Turbidity (FTU)	0.3 - 3.4
Colour (TCU)	2 - 18
Hardness (mg/L as $CaCO_3$)	125 - 130
Alkalinity (mg/L as $CaCO_3$)	89 - 102
pH	7.64 - 8.3
Iron (mg/L)	<0.05 - 0.85
Total Coliform (per 100 ml)	0 - 2100
Fecal Coliform (per 100 ml)	0 - 90

The above water quality parameters are based on monthly samples analysed at the MOE lab, Resources Road, Rexdale, Ontario. The information therefore, is representative of single grab samples taken each month.

Detailed raw water quality records are provided in Appendix A.

A.2 Relative Elevation

The lake level varies from approximately 72 to 73.6 m above sea level. The Cornwall WTP is constructed at an elevation of approximately 63 m and therefore, has a gravity supply, thus eliminating the need for a low lift pumping station.

SECTION B

FLOW MEASUREMENT

SECTION B
FLOW MEASUREMENT

B.1 Raw

The raw water is metered by a 915 mm universal insert venturi meter which has a capacity of 113 ML/d. From the flow data recorded in Appendix A, the raw water operating range varied from 24.8 to 74.1 ML/d during 1983-1986. The raw water flow is recorded continuously on a chart in the control room. The totalized flow is recorded every 24 hours on the daily record.

Table 1.0, Appendix A, of this report records raw and treated water flows on a monthly basis from 1983 to present. The information on Table 1.0 was taken from monthly log sheets at the Cornwall WTP.

In 1983, the recorded flows show a large discrepancy between raw and treated. From 1984 to present, the recorded values for raw and treated appear to be consistent.

B.2 Treated

Presently, there are two watermains leaving the Cornwall WTP, and each has its own venturi meter. The flow range for each meter is 27 to 114 ML/d. From 1984 - 1986 treated water flows have ranged from 27 to 74 ML/d. When these flows are split between two meters, it is obvious that the flow through each meter may be below its' operating range. Inaccurate treated water flow rates may have been recorded during low treated water flow periods.

The treated water flow is recorded continuously on two charts in the control room. The totalized flow is recorded every 24 hours on the daily record.

In 1978, it was recognized that treated water metering at Cornwall was a problem at low flows. Attempts were made at that time to rectify the problem; however, it is apparent that additional remedial action is required to correct this problem.

B.2 Treated (cont'd)

Simcoe Engineering's Master Plan Study recommends that the existing discharge mains be connected outside the plant and then use only one of the meters. This would certainly increase the flow through the active meter and improve its' accuracy. The second meter would then be available for standby.

B.3 Backwash

There is one backwash pump, and it is metered by a 508 mm venturi tube flow meter. The capacity for the meter is 64 ML/d.

If the pump is out of service for any reason, it is possible to backwash filters using flow from the high lift pumps. In this mode of operation, the backwash flow is still measured using the same meter. This type of operation may cause filter disruption problems if the flow is too great. This emergency system should be examined with a view to ensuring the protection of the filters.

B.4 Filters

Each of the four filters is separately metered with a venturi. The original filter rate controllers were replaced at two different stages with larger venturi meters and filter flow rate control valves in order to increase the capacity of the filters. The capacity of each filter is presently being evaluated, and further investigation is required to determine the flow ranges of the four venturi meters.

The maximum filter rates are set at each filter, but can be cut back by a clearwell level override.

B.5 Validity

There are no absolute minimum effective capacities for each venturi meter, however, unreliable flow measurements are usually experienced when the flowrate is less than 20% of the meter's rated capacity. Occasionally, the above mentioned venturi meters operate at flows less than 20% of their rated capacities.

B.5 Validity (cont'd)

Simcoe's Master Plan Study recommends verification of all the meters on the site. Initially, the most important meters to deal with are the high lift discharge meters, because they are known to be unreliable at low flows.

The flow data in Table 1.0 of Appendix A shows a systematic set of information, with the exception of the treated water flows in 1983. The treated water metering requires remedial action as described in the Simcoe report.

The per capita flow data provided in Table 1.1 of Appendix A indicates a high average and maximum daily usage. The plant metering is suspect, and there also may be leakage in the system. The per capita flows should be examined further when the treated water metering is rectified.

SECTION C

PROCESS COMPONENTS

SECTION C
PROCESS COMPONENTS

C.1 General

The following drawings are included in Appendix E:

- (a) Site Plan
- (b) Diagramatic Layout
- (c) Block Schematic

This section includes detailed information on Design Data and Chemical Systems.

This section also contains a series of photographs to illustrate the major plant components and chemical feed systems.

C.2 Design Data

(a) Plant Capacity

The Cornwall Water Treatment Plant has been serving the city since 1956. The original design capacity was 45 ML/d. Over the intervening years, larger filter inlet sluice gates, larger filter rate controllers, additional high lift pumps and filter media changes have increased the plant flow.

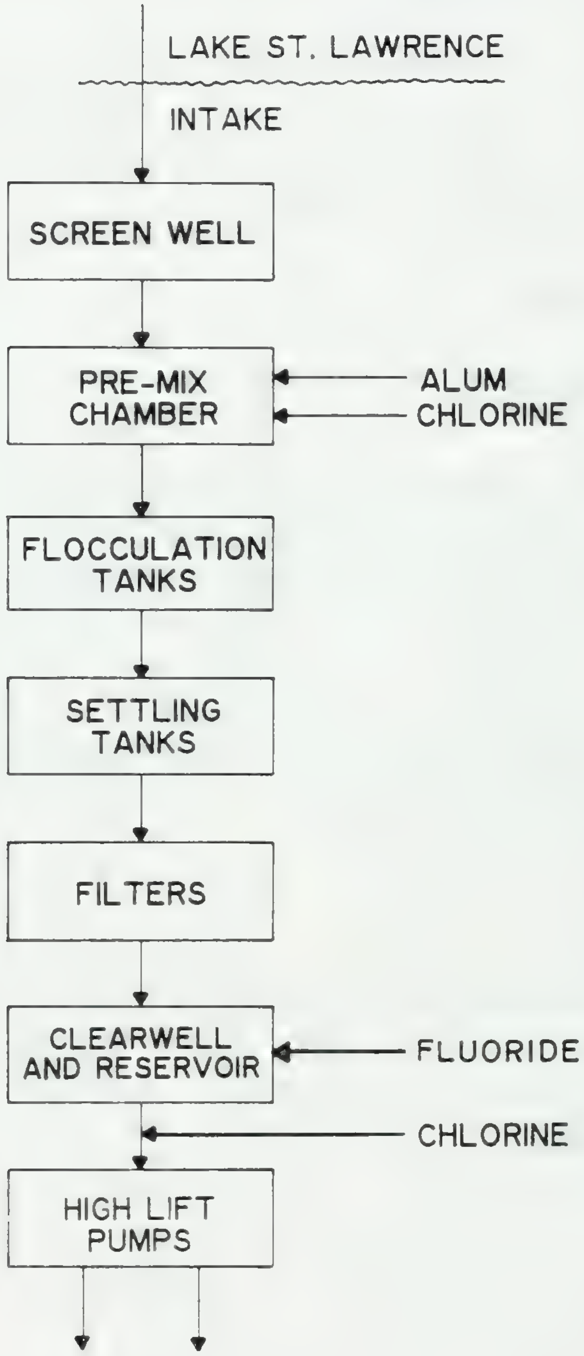
The rated capacity of the facilities is 100 ML/d, with a present average daily flow of approximately 45 ML/d. All of the operating data presented herein are based on flows of 45 and 100 ML/d.

(b) Intake

The intake is a 1067 mm concrete pipe, 3628 metres long with approximately 135 metres of 1219 mm steel pipe. The capacity of the intake is 100 ML/d. This capacity was confirmed in 1986 by Simcoe Engineering with Lake St. Lawrence level at 73.01 metres.

FIGURE I

CORNWALL WATER TREATMENT PLANT
PROCESS AND PIPING SCHEMATIC



(c) Screening

There is one FMC Linkbelt, Model 46A, travelling water screen, 0.91 m wide, in the Screen Building. The mesh material is 1.83 mm diameter phosphor-bronze wire with 7.42 mm square openings. The capacity of the screen was established by Simcoe Engineering in 1986 to be 114.5 ML/d.

Operation of the screen is either manual or automatic based on differential head across the screen.

Screen wastes are discharged to a stationary basket screen and the flushing water is discharged to the sanitary sewer. Any solids that are caught in the stationary basket screen are hauled away from the site.

(d) Low Lift Pumping

The Cornwall plant has a gravity supply from Lake St. Lawrence via the 1067 mm diameter intake; therefore, there are no low lift pumps. There is a 900 mm inlet control valve located in the screen house at the plant. The raw water flow rate is controlled by the modulated position of this valve.

(e) Flash Mixing

There can be two purposes for mixing of chemicals into the main process stream: blending and flash mixing. Blending consists of the distribution of chemicals uniformly throughout the body of the process stream and is characterized by relatively high velocity gradients of greater than 200 sec^{-1} for periods of up to several minutes. Flash mixing addresses the coagulation concept that blending must occur within a very short period of time, a matter of seconds, and this requires very high velocity gradients of greater than 1000 sec^{-1}. It is important to recognize the difference between these two concepts and their process implications. Blending mixing is to ensure that the process components will behave uniformly. Flash mixing has been espoused by some researchers in water chemistry as improving the coagulation process.

(e) Flash Mixing (cont'd)

There is no mechanical flash mixing; however, a concrete chamber, which is actually part of the screen chamber, provides limited hydraulic mixing. Water enters the chamber by passing through the travelling water screens, therefore, the mixing energy evaluation can not be calculated by considering loss of momentum. The chamber is approximately 3.6 m x 3.6 m x 7.5 m deep. Chlorine and alum are added in the pre-mix chamber. The detention times at 100 and 45 ML/d are 84 and 187 seconds respectively.

(f) Flocculation

The flocculation tanks are hydraulic spiral flow and are made of concrete. There are 2 sets of 3 cells which provide 2-stage flocculation. Each of the 6 tanks is 4.82 m x 4.82 m x 6.69 m deep. The total volume of the flocculation tanks is 930 m^3. The flocculation detention times at 100 and 45 ML/d are 13 and 30 minutes, respectively, based on the total tank volume.

The mixing velocity gradients in the flocculation tanks have been estimated based on a mixing energy input equivalent to the loss of momentum of the water entering the tanks. This is a conservative estimate of the total mixing, since other energy loss occur during passage of the water from one tank to another. This additional mixing energy could result in G values which are as much as 25 percent higher. The actual energy loss can be obtained from precise hydraulic tests.

Useful flocculation velocity gradients range from 100 to <10 sec^{-1}. A "tapered" or stepped series should be used; the highest mixing is provided initially, progressing through a series of cells of decreasing mixing levels. Additionally, the dimensionless parameter, Gt, which is the product of velocity gradient and the duration of mixing, is a most useful parameter which usually must have values within the range of 10^4 to 10^5.

(f) Flocculation (cont'd)

Estimated Velocity Gradient at 10°C, based on total tank volume:

	45 ML/d	100 ML/d
Cell 1	$G = 40\ s^{-1}$	$G = 132\ s^{-1}$
Cells 2-3	$G = 9\ s^{-1}$	$G = 30\ s^{-1}$
Overall	$Gt = 3.0 \times 10^4$	$Gt = 4.4 \times 10^4$

If the plant flowrate was 100 ML/d, the resultant G values would be too high, which would result in break up of the floc.

(g) Settling Tanks

The settling tanks are horizontal cross-flow and are made of concrete.

There are two tanks, 15 m x 24 m x 5.2 m deep each. Each settling tank is fed from the flocculated water conduit via twelve 300 mm x 300 mm ports.

The total volume and surface areas of the settling tanks are 3744 m^3 and 720 m^2, respectively. The detention times at 100 and 45 ML/d are 54 and 120 minutes, respectively, based on the total tank volumes. For similar flow conditions, the overflow rates are 5.8 and 2.6 m/h, respectively.

(h) Filters

Cornwall has 4 filters in total. Each filter has a separate flow meter. The settled water is collected in a settled water conduit, and is distributed to the filters via the washwater troughs.

Two filters are dual media, and two filters are multimedia. All filters are constant rate, have surface agitators, and have Leopold clay block underdrains.

All filter boxes are constructed of concrete.

FILTERS 1-4

	W(m)	L(m)	(1) D(m)	Surface Area (m^2)	Gross Vol. (m^3)	(2) Net Vol. (m^3)
Individual	6.4	12.8	2.4	81.9	196.6	104
Total	-	-	-	327.6	786.4	416

Notes: (1) D (m) is depth of water in filter box in meters.

(2) NET VOL. (m^3) assumes a filter media porosity of 0.4.

(3) Media depth including underdrains is 1.890 m.

		Sand	Anthracite
Filter No. 1	ES	0.33*	0.87
	UC	2.3	1.65
Filter No. 2	ES	0.33*	0.76
	UC	2.45	1.95
Filter No. 3	ES	0.65	0.84
	UC	1.25	1.61
Filter No. 4	ES	0.62	0.90
	UC	1.29	1.54

NOTE: Above ES and UC information taken from Simcoe Engineering Master Plan Study dated 17 March 1987.

* The multi media filters may have higher density sands

EFFECTIVE SIZE: This is the sieve size on which 90% of the filter medium will be retained, i.e. 10% of the medium is finer than the sieve size. Effective size is determined by interpolation of the sieve analysis results.

UNIFORMITY COEFFICIENT: This is the ratio of the sieve size that retains 40% of the medium to the sieve size that retains 90% of the medium. Uniformity coefficient is a guide to how uniform in size the medium is.

Filter Nos. 1 and 2 contain a multi-media as supplied by Neptune Microfloc, whereas Filters 3 and 4 contain a conventional sand and anthracite dual media. The multi-media in Filters 1 and 2 have a much finer sand than the other two filters. As a result of the small sand, Filters 1 and 2 accumulate head loss at a faster rate than Filters 3 and 4.

The finer sand should produce a lower turbidity in the filtered water; however, filter effluent turbidities are not measured or recorded as part of regular plant operations, therefore, there is no information as to the relative performance between Filters 1 - 2 and Filters 3 - 4. Testing should be conducted to evaluate the relative performances of the filters.

OPERATING PARAMETERS

Length of Run	48 hr. max. (Typ. in Winter) 24 hr. max. (Typ. in Summer) All based on present average day flows	
Headloss (clean bed/dirty bed)	0.45 - 1.8 m	
Flow Rate	Total Flow (ML/d)	Filtration Rate (m/h)
	100	12.7*
	45	5.7
Backwash Flow	Low: 18.5 m/h High: 32.3 m/h	
Backwash Water/Wash	3.0 to 6.5 m^3/m^2 range 4.4 m^3/m^2 (average)	

* Exceeds MOE Design Guidelines, however, given the low raw water turbidity, the solids loading is correspondingly low even at these higher flowrates.

(h) Filters (cont'd)

The backwash system at the Cornwall plant consists of one 64 ML/d Fairbanks-Morse electric pump (head = 10.4 m). The pump draws water from the clearwell.

The backwash procedure is outlined in Appendix B and is a manual operation. The backwash flow is controlled by a rate control valve, and the metering is discussed in Section B.3. All filters are equipped with surface agitators, which, in general, operate at flows of 1.8 m/h at the plant service water pressure.

(i) Clearwells

The clearwell and reservoir are constructed of concrete.

Under Filters 1-4:	1.67 ML
On-Site Reservoir:	3.08 ML
TOTAL:	4.75 ML

(j) High Lift Pumping

All high lift pumps are horizontal centrifugal.

NO.	TYPE	CAPACITY (ML/d)	RATED HEAD (kPa)	POWER (kW)
1	Electric	36.4	540	298
2	Electric	22.7 ea.	540	185
1	Diesel	36.4	567	335
1	Diesel/Elec.	36.4	671	-
	Total Installed	154.6		
	Firm Capacity	118.2		

Due to the hydraulic restrictions within the plant at the time of this report, the quantity of water supplied to the reservoir is below the firm capacity of the high lift pumps.

(k) Backwash Treatment

Presently, the plant has no waste treatment facilities. The backwash water is discharged to a sanitary sewer and treated at the Cornwall Water Pollution Control Plant. The quantity of solids discharged into the lake and possible treatment methods are discussed in more detail in the supplemental Water Plant Optimization Study waste treatment report.

(l) Sludge Disposal

The settling tank sludge is also discharged to a sanitary sewer and treated at the Cornwall Water Pollution Control Plant. Again, the quantity of solids discharged into the lake and possible treatment methods are discussed in more detail in the supplemental Water Plant Optimization Study waste treatment report.

C.3 Chemical Systems

(a) Disinfectant

Chlorine is stored as a liquid in 0.9 tonne cylinders. The chlorine storage area is located in the southwest corner of the plant. The storage room has space for six one tonne chlorine cylinders.

Application points:

Pre - Pre-mix chamber (before floc tanks)
Post - Clearwell effluent (prior to high lift pumps)

Equipment:

Pre - 1 Wallace & Tiernan 113 kg/d Chlorinator
Post - 1 Wallace & Tiernan 45 kg/d Chlorinator
- 1 Chlorine Residual Analyser
Standby - 1 Wallace & Tiernan 113 kg/d Chlorinator

The pre-chlorine feed rate of 113 Kg/d results in a maximum dosage of 1.13 to 2.5 mg/L for 100 and 45 ML/d flow rates, respectively.

(a) Disinfectant (cont'd)

The pre-chlorine dosage ranges from 0 to 1.1 mg/L. The pre-chlorine dosage is flow paced on the raw water flow signal. Pre-chlorine is added into the screen chamber to obtain a filter effluent free chlorine residual of 0.1 mg/L, as verified by hourly amperometric measurements.

The post chlorine feed rate of 45 Kg/d results in a maximum dosage of 0.45 and 1.0 mg/L for 100 and 45 ML/d flow rates, respectively. The post-chlorine dosage ranges from 0 to 0.45 mg/L. The post-chlorine dosage is flow paced on the summated treated water flow signal and is residual controlled (compound loop). A free chlorine residual of 0.3 mg/L is maintained in the high lift discharge, as measured by a Wallace & Tiernan continuous chlorine analyzer.

(b) Coagulant

Liquid alum is stored in a 31,000 L, PVC-lined rectangular wood stave storage tank. The alum usage is totalized by a Neptune meter on the storage tank effluent.

Alum is fed with a Reliance Series 44-113 positive displacement metering pump. An identical standby pump is also available. The rated capacity of each pump is 2250 L/d. The maximum dosage capacities are 15 and 33 mg/L for 100 and 45 ML/d, respectively.

The stroke position is manually set and the speed is flow paced from the continuous raw water flow signal. The application point is the screen chamber.

(c) Fluoride

Fluoride is added in the form of hydrofluosilicic acid. The acid is stored in a polyethylene lined 35,000 L wood stave storage tank.

There are 2 Reliance model 44-112 positive displacement metering pumps; one service, one standby. The capacity of each pump is 500 L/d. The maximum dosage capacities are 1.2 and 2.7 mg/L for 100 and 45 ML/d, respectively.

The stroke position is manually set and the speed is flow paced from the totalized flow signal from the two treated water venturi meters. The application point is in the clearwell.

C.4 Photographs

Following is a series of photographs to illustrate major components and chemical feed systems.

CORNWALL WATER TREATMENT PLANT

ADMINISTRATION AND FILTER BUILDING

TRAVELLING WATER SCREENS

CHLORINE APPLICATION POINT - TWS WELL

ALUM METERING PUMP

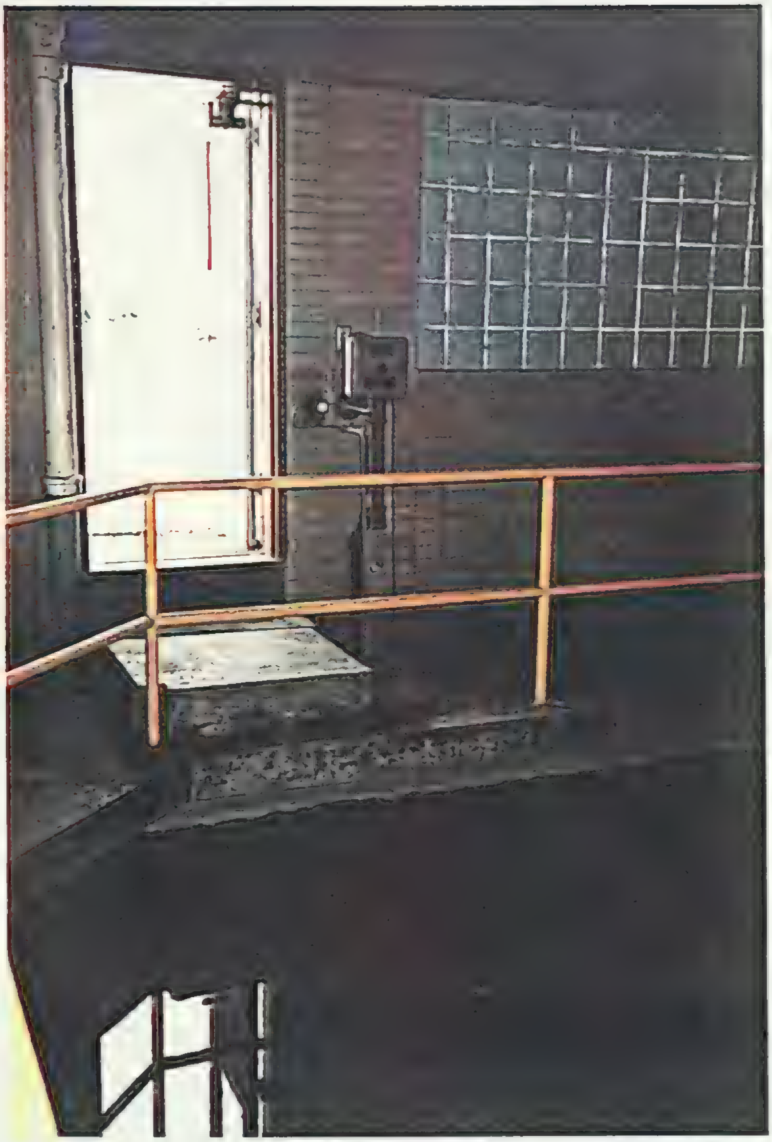
LIQUID ALUM STORAGE TANK AND METERING PUMPS

HYDROFLUOSILICIC ACID STORAGE TANK AND METERING PUMPS

CHLORINE STORAGE AND BACK OF ADMINISTRATION BUILDING

TRAVELLING WATER SCREENS AND PRE-MIX CHAMBER

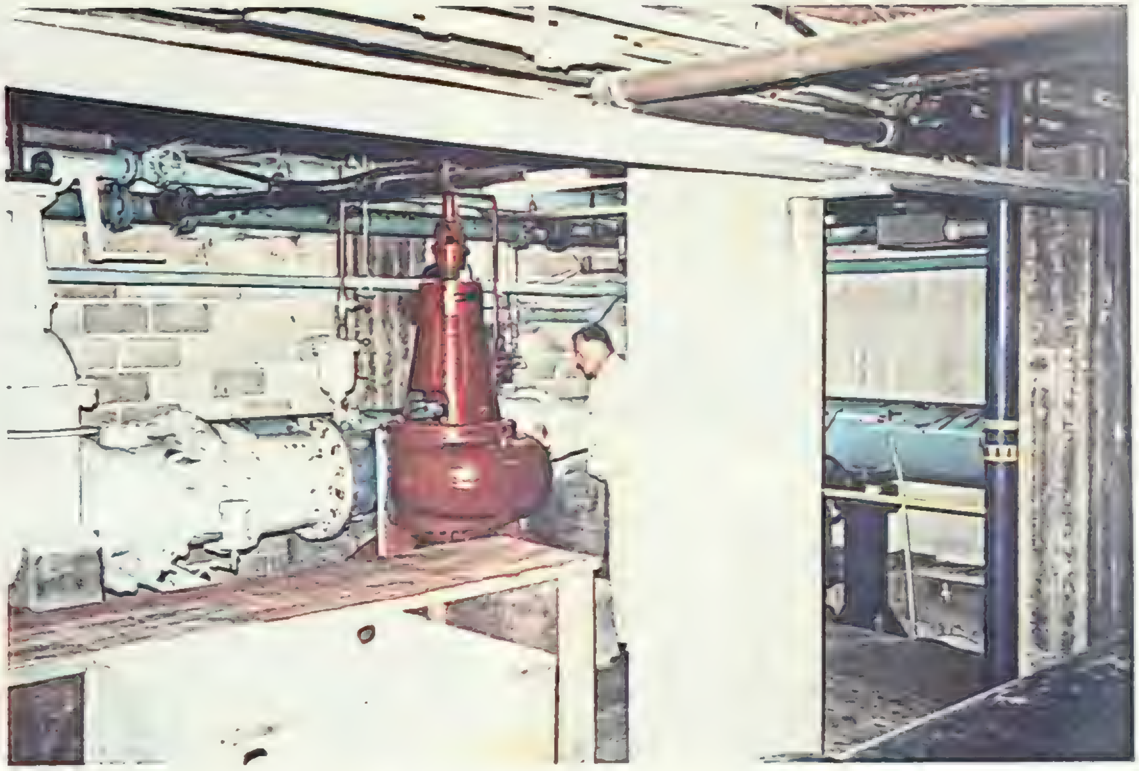
SETTLING TANKS



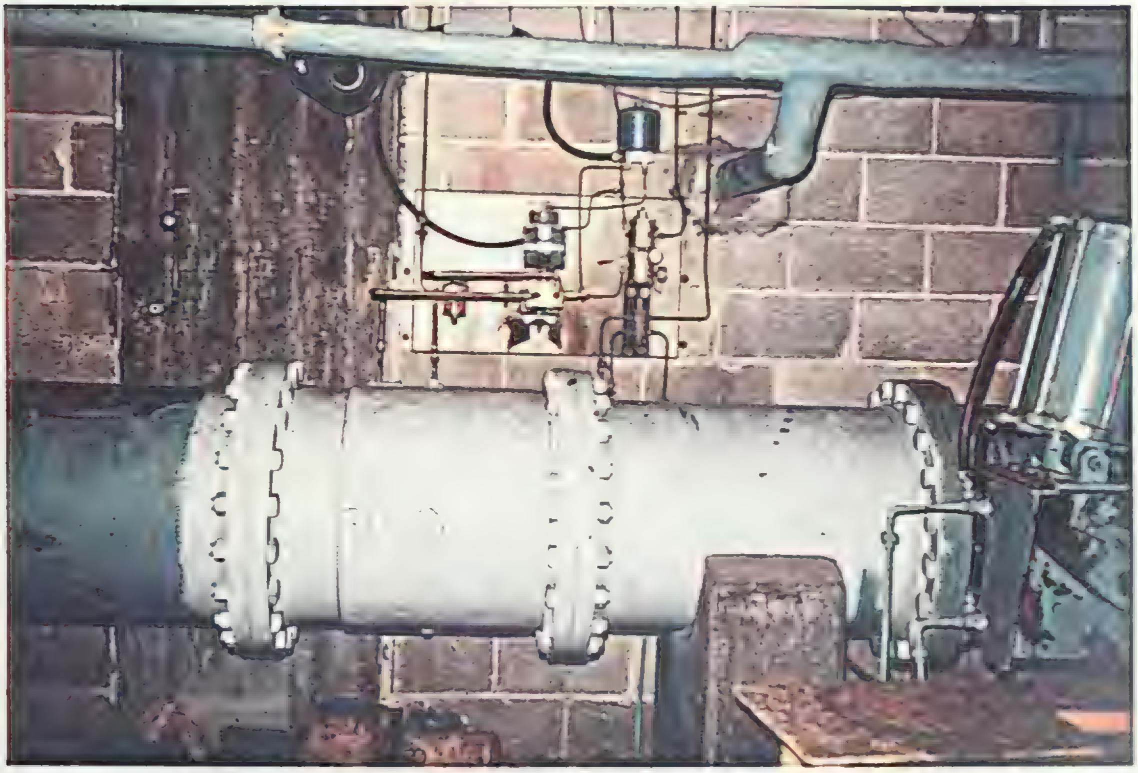
SETTLED WATER LEVEL TRANSMITTER

FILTER GALLERY

FILTERS



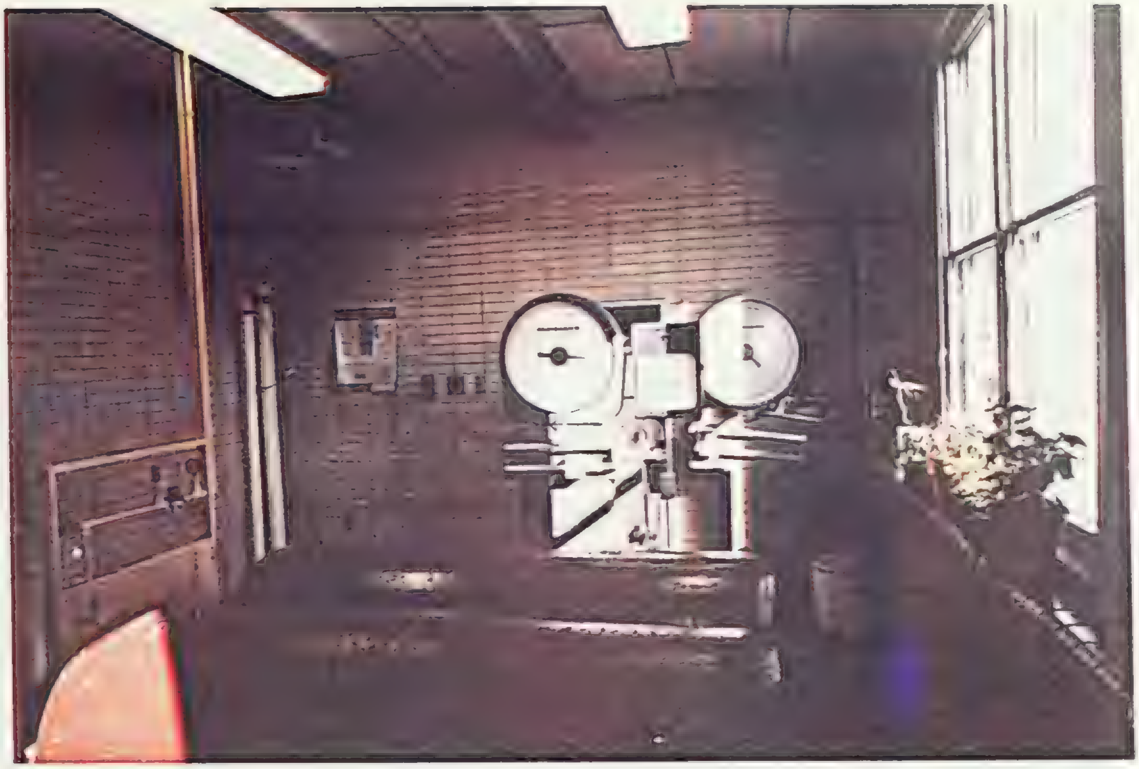
WASHWATER PUMP



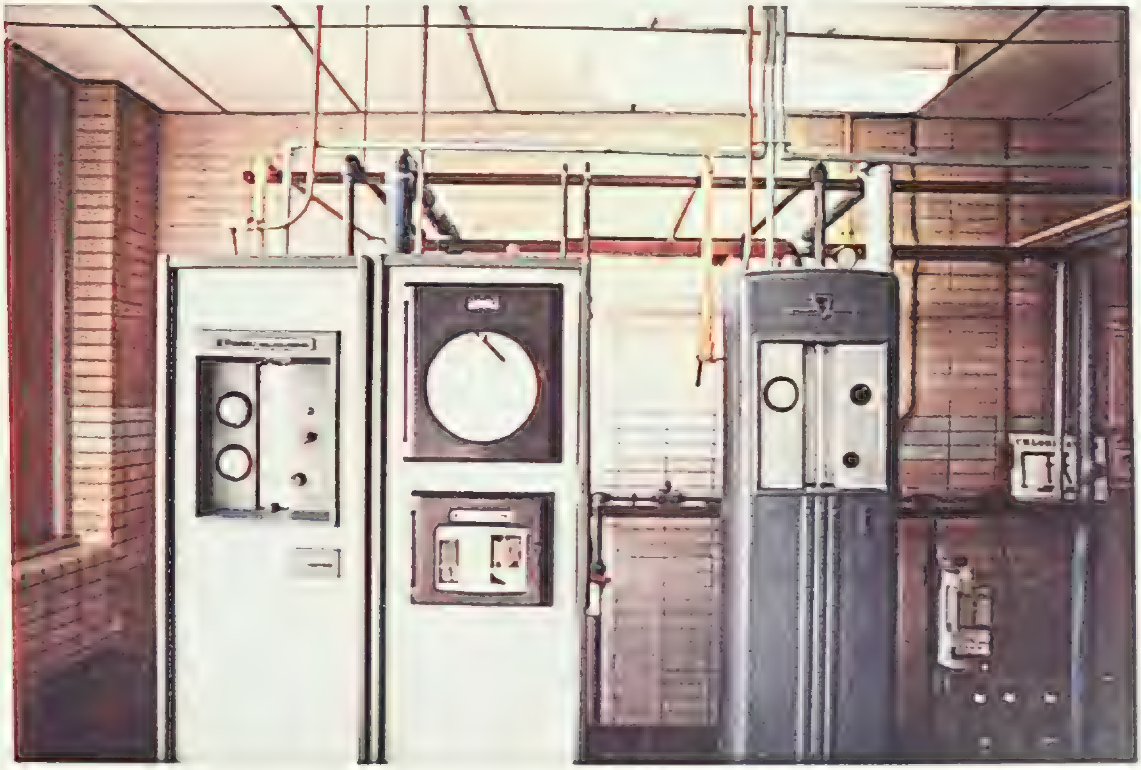
WASHWATER FLOW TRANSMITTER

FILTER HEADLOSS INDICATOR

WORKSHOP



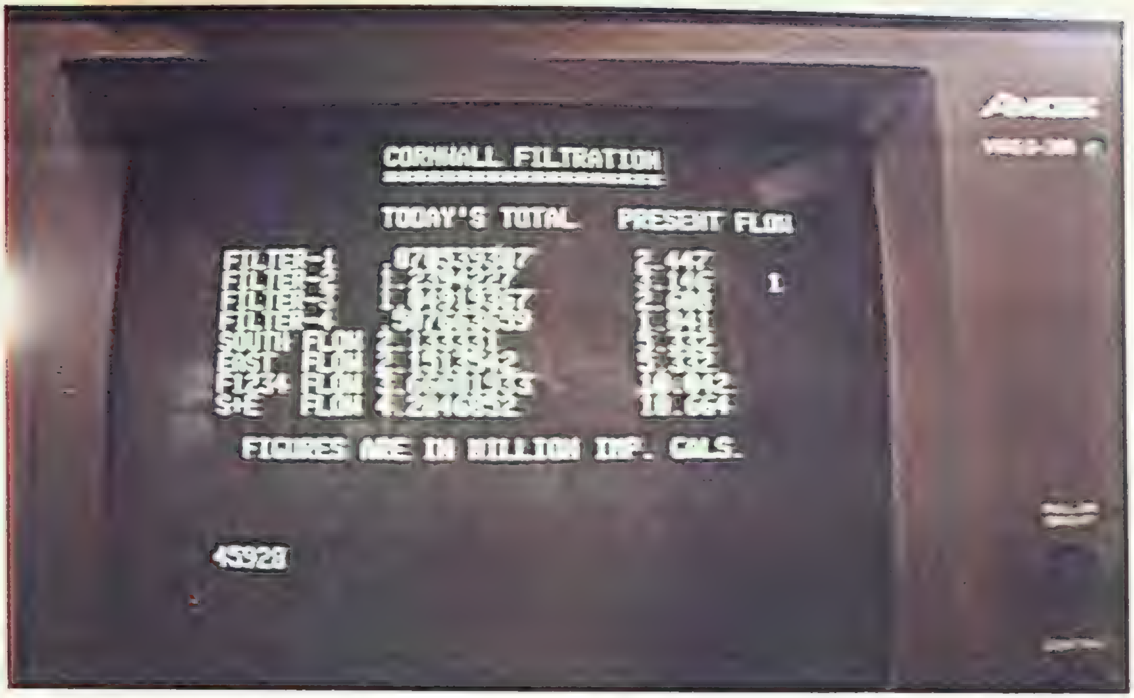
CHLORINE ROOM - CHLORINE CYLINDERS AND WEIGH SCALES



CHLORINATORS AND POST CHLORINE RESIDUAL ANALYZER

CONTROL ROOM

CONTROL ROOM



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CORNWALL FILTRATION

TODAY'S TOTAL   PRESENT FLOW
FILTER-1    [illegible]   2.447
FILTER-2    [illegible]   [illegible]   1
FILTER-3    [illegible]   [illegible]
FILTER-4    [illegible]   [illegible]
SOUTH FLOW  [illegible]   [illegible]
EAST  FLOW  [illegible]   [illegible]
F1234 FLOW  [illegible]   [illegible]
S+E   FLOW  [illegible]   [illegible]
FIGURES ARE IN MILLION IMP. GALS.

45928
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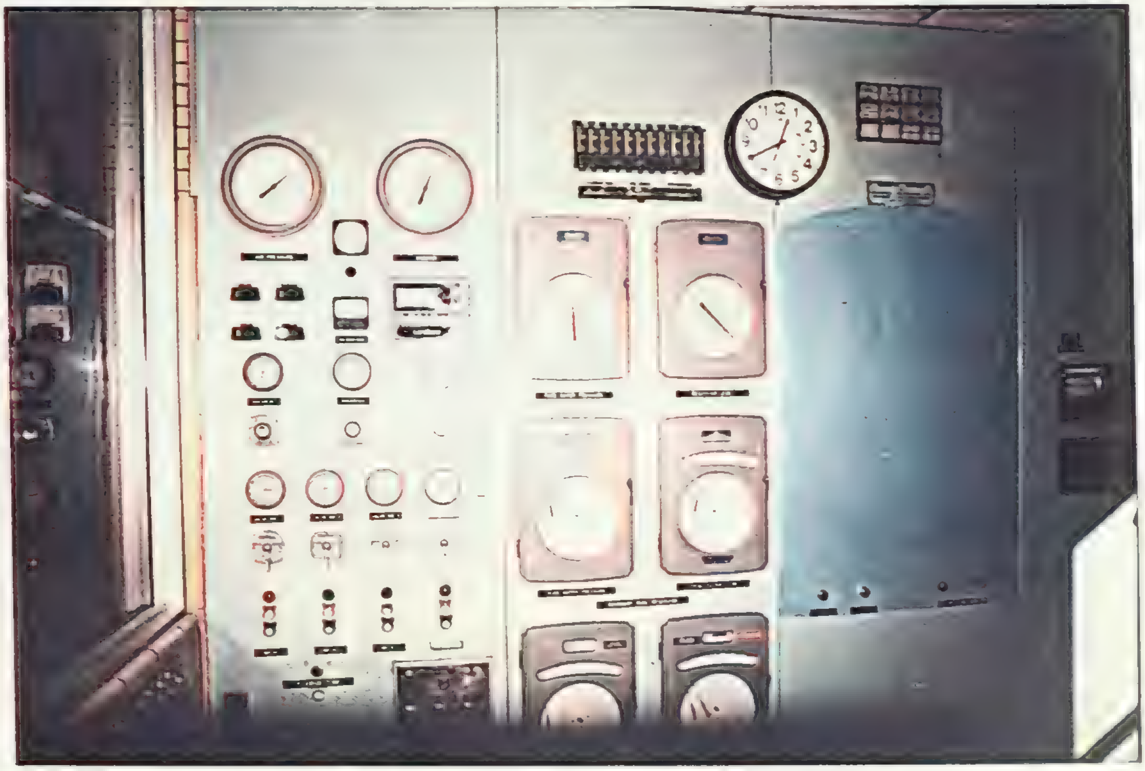
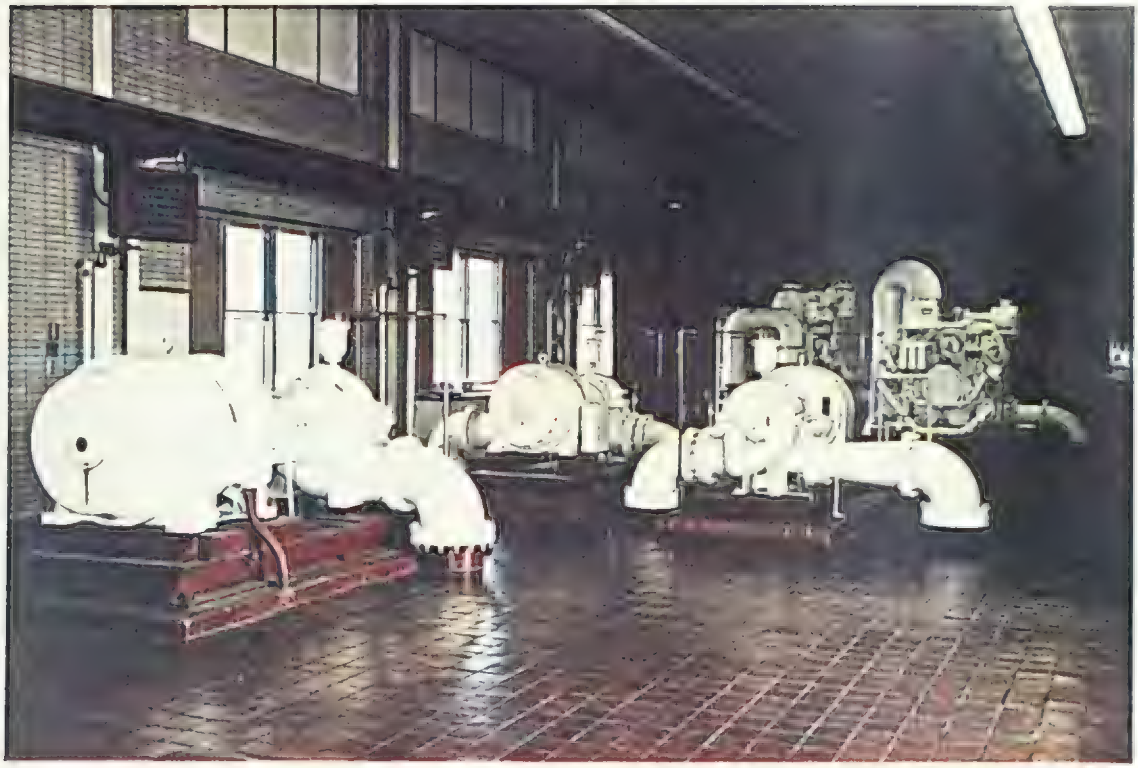
OPERATORS VDT - FILTRATION RATES



CONTROL ROOM - INDICATOR/RECORDERS



HIGH LIFT PUMPS

HIGH LIFT PUMPING STATION PIPING

SECTION D
PLANT OPERATION

SECTION D
PLANT OPERATION

D.1 Description

(a) General

The plant was originally constructed in 1956, and numerous piping, process and instrumentation changes have occurred over the subsequent years.

The plant is presently undergoing several modifications. Flocculation and settling tank improvements, as well as treated water metering adjustments, will be undertaken during 1987. Further modifications will be made in 1988.

(b) Flow Control

RAW WATER

The plant is fed with raw water via a raw water control valve. The modulating raw water control valve adjusts the flow to maintain the water level on the filters within a 150 mm band.

PRE-TREATMENT AND SEDIMENTATION

All of the flocculation and sedimentation tanks are used all of the time.

FILTRATION

The filter rates can be individually set at each filter operating table or they can be controlled by the Master Filter Rate Setter in the main plant control room. Normal operation is to control filter rate with the Master Rate Setter. All of the filters are normally operated all of the time.

As the on-site clearwell and reservoir approach a full condition, a Clearwell Level Override system causes the Master Filter Rate Setter to decrease the filter flow. Conversely, a dropping water level in the clearwell causes the filter rate to increase up to the set point on the Master Filter Rate Setter.

HIGH LIFT PUMPING

The plant operator selects the number of high lift pumps required to maintain the system pressure and/or fill the Boundary Road reservoir.

The high lift discharge pumping rate is based on the distribution system demand and the water level in the Boundary Road 9.0 ML ground storage reservoir. System pressure at the plant is maintained at 450 - 525 kPa during the day and raised to 550 kPa during reservoir filling at night.

Some of the plant operational procedures are summarized in Appendix B.

(c) Filter Backwashing

The criteria used to initiate a filter backwash is either headloss or time. There are no on-line turbidimeters to measure individual filter effluent turbidities. A copy of the backwashing procedure used at the Cornwall Plant is included in Appendix B.

During the summer months, the filters are normally washed after 24 hours; during the winter months, this time period is usually extended to 48 hours. If the headloss on any filter reaches 1830 mm, it is washed regardless of the number of hours in service.

The low and high wash rates of 18.5 and 32 m/h provide a bed expansion of approximately 2% and 17%, respectively, at 15°C. As noted earlier, the volume of water used during a backwash is 3.0 to 6.5 m^3/m^2. Our experience indicates that a wash volume of 4.0 to 5.0 m^3/m^2 should properly clean a filter bed.

(d) Chemical Dosage Control

Alum, chlorine, and fluoride are added year round. The most important chemical to control from a particulate removal performance view point is alum.

(d) Chemical Dosage Control (cont'd)

ALUM

Alum dosages vary from 0 to 15 mg/L. Alum is added in the screen chamber.

Raw water quality changes are gradual and relatively small; therefore, the corresponding alum dosage adjustments are also small.

Jar tests are rarely performed; rather, historical operating knowledge is used. Presently, adjustments are made to alum dosage based on experience and observation of the length of the filter runs.

Alum dosage is set at the metering pump by manual stroke adjustment, and the metering pump speed is flow paced from the raw water flow signal. The metering pumps are calibrated once a month. Daily alum usage is determined from 24 hour integrator readings, as measured by a Neptune meter on the storage tank effluent. The alum dosage is verified by the daily usage and the daily raw water flow rate.

CHLORINE

Pre-chlorine is added in the screen chamber to obtain a free chlorine residual of 0.1 mg/L in the filter effluent. The free chlorine residual of one of the filter effluents is measured hourly by an amperometric titration.

Post-chlorine is added at the common high lift pump suction header to achieve a free chlorine residual of 0.3 mg/L in the high lift discharge. This chlorine residual is monitored continuously. Twice a day, the free chlorine residual is measured by an amperometric titration on samples taken from the sample line in the chlorinator room. The sample line originates from the south plant effluent. These chlorine residual determinations are used as a check on the continuous chlorine analyzer.

Chlorine dosage is verified by weigh scale readings of chlorine cylinders taken on a daily basis.

(d) Chemical Dosage Control (cont'd)

FLUORIDE

Fluoride is added in the clearwell using hydrofluosilicic acid. The acid is added by one of two 500 L/d metering pumps. The dosage is set at the metering pump by a manual stroke adjustment and the pump speed is flow paced from the treated water flow.

The fluoride residual is continuously monitored on the high lift discharge.

Daily hydrofluosilicic acid usage is determined by measuring the level drop in the bulk storage tank. The fluoride dosage is verified by the daily usage and the treated water flow rate.

(e) Quality Control Testing

The following table lists pertinent information on the sample systems in use at the Cornwall plant:

SOURCE	LENGTH/SIZE (m/mm)	FLOW (L/min.)		VELOCITY (m/s)		TRAVEL TIME (min.)	
		Max.	Norm.	Max.	Norm.	Min.	Norm.
Raw Water (to lab)	50/19.0		9.75		0.45		1.85
Individual Filter Effluents (to drain)	/12.7						
High Lift Discharge (to lab)	9.1/19.0		8.1		0.37		0.40

Note: Raw water sample line is made of ABS. Treated water sample line is made of copper.

The sample flow rate for each source was determined by a time-displacement test. These tests were conducted in February 1987.

The sample line from the high lift discharge splits into two branches. One goes to the laboratory (19.0 mm diameter pipe), the other feeds a continuous chlorine analyzer (12.7 mm diameter pipe).

(e) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT
Cl_2 Residual:				
- pre, free	Filter effluent	Once/hour	Once/hour	W&T Amperometric Titration
- post, free	High Lift Discharge	Continuous	Hourly	W&T Continuous Chlorine Analyzer (calibrated 1/2 weeks)
- post, free	High Lift Discharge	Twice/day	Not reported	W&T Amperometric Titration
Turbidity	Screen House	Once/day	Once/day	HACH 2100A (calibrated 1/4 months, standardized daily)
	High Lift Discharge	Once/day	Once/day	HACH 2100A
Fluoride	High Lift Discharge	Continuous	Twice/day	Uniloc 1033 Selective Ion Analyzer (calibrated 1/2 months, checked daily)
pH	Lab Taps, Raw and Treated	Once/month	Once/month	Done at MOE Kingston Lab
Temperature	High Lift Discharge	Continuous	Once/hour	Metallic Strip
Bacteriological Testing	Screen House and High Lift Discharge	Once/week	Kept on file but not reported in any other manner	Standard Membrane Filtration Apparatus (Done at MOE Kingston Lab)
	Distribution System (8 locations)	Once/week	Kept on file but not reported in any other manner	Standard Membrane Filtration Apparatus (Done at MOE Kingston Lab

D.2 Operational and Process Concerns

(a) Raw Water Meter

The accuracy of this meter is questionable and should therefore be checked.

(b) High Lift Metering

The 1986 flows ranged between 32 and 60 ML/d and if they were split 50/50 between each of the two meters, the flow range per meter would only be 16-30 ML/d. The capacity range of each meter is 27 - 114 ML/d. It is obvious that the meters are oversized for the present flows.

One of the recommendations in the Simcoe report is to change the piping to direct all of the flow through a single meter, leaving the second one as a standby. Either this or replacing the present meters with smaller ones would solve the problem.

(c) Hydraulic Restrictions

The original plant was designed for 45 ML/d and now has a maximum capacity of 100 ML/d. Hydraulic restrictions in the flocculation and settling tanks must be removed, thus lowering the headloss through the plant, to allow continuous operation of the plant at rates of 100 ML/d. The present high 'G' values will be reduced to values associated with the original design parameters.

(d) Screen Chamber

At 100 ML/d, the detention in the concrete chamber of the screen chamber is 84 seconds, whereas, at the 1986 flow range of 32-60 ML/d, the detention would be between 140 - 262 seconds. The mixing energy in this chamber is not controlled, and consideration should be given to other forms of mixing if it is shown that this is a deterrent to optimizing coagulant performance.

(e) Daily Log Sheet

Prior to September 1986, samples of raw and treated water were checked for turbidity by the plant operators but not recorded in a regular or consistent fashion. The daily log sheets were changed in September 1986 to accomodate daily turbidity readings.

(f) Alum Application

From 1983 to the present, there have been lengthy periods of time where alum and/or fluoride have not been added to the water due to operating budget restraints.

In the past, there had been a tendency in the water treatment industry to stop using alum during periods of low raw water turbidity. This practice does not allow the plant process components to effectively remove particulate material such as turbidity and certain micro-organisms such as Giardia cysts. Consideration should be given to adding a coagulant at all times.

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

SECTION E
PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal

(a) General

The Cornwall plant must treat the following raw water quality conditions:

Turbidity (FTU)	0.3-3.4
Colour (TCU)	2-18
Iron (mg/L)	<0.05-0.84

The raw water quality is very good and is consistent all year. Considering turbidity alone, the raw water conditions would allow treatment by direct filtration (that is, a plant without settling tanks) to meet today's treated water objective.

(b) Plant Performance

OVERALL PLANT PERFORMANCE

It is usual to consider two conditions for plant operation, the maximum hydraulic flow rate (100 ML/d) and the maximum process flow rate. The maximum process condition, from the standpoint of particulate removal, occurs with the highest solids loading on the plant. At Cornwall, due to the consistently good raw water quality, the plant is able to operate at the current maximum hydraulic flow rate and does not have a lower maximum process flow rate. If the hydraulic restrictions are removed and the hydraulic capacity increases significantly, the process flow rate may be the limiting factor.

As stated before, there were periods during 1983 - 1986 when alum was not added. The plant's turbidity records are not adequate to make a judgement as to the effectiveness of the plant on a continuous basis. The table following presents "limited" information on turbidity performance during 1986.

DATE	TURBIDITY (FTU)		COMMENTS
	Raw	Treated	
14 Jan/86	1.3	0.33	
4 Feb/86	1.7	0.38	Alum off
18 Mar/86	0.53	0.54	Alum off
15 Apr/86	0.52	0.38	
13 May/86	0.63	0.46	
22 Jul/86	0.75	2.1	Alum off
19 Aug/86	0.9	0.38	
23 Sep/86	0.73	2.7*	
7 Oct/86	1.6	0.28	

* MOE lab noted that sample contained large particles like kettle scale

The above records demonstrate turbidity removal when a coagulant is added. However, daily data is required for control of the plant and to serve as historical data to confirm the plant's performance.

ASSESSMENT OF OVERALL PERFORMANCE

The turbidity guideline in the Province of Ontario is 1.0 FTU; but clearly, it is important to reduce the turbidity to as low a level as practical.

As mentioned earlier, there have been lengthy periods when alum has not been added to the water during 1983 to 1986. In the past, there had been a tendency in the water treatment industry to stop using alum during periods of low raw water turbidity. This practice does not allow the plant process components to effectively remove particulate material such as turbidity and certain micro-organisms such as Giardia cysts.

When the proper amount of coagulant is used, the floc agglomerates and entraps small particles which thereby enables the filters to remove these particles that would otherwise pass through.

(b) Plant Performance (cont'd)

Historic records of the plant as related to turbidity are limited; therefore, a detailed assessment cannot be made. The few records that are available indicate that the plant is producing water with a turbidity of <1.0 FTU when alum is being used.

E.2 Treatability Testing

(a) Jar Testing

TURBIDITY REMOVAL

Treatability testing was carried out on a raw water sample with a turbidity of 1.2 NTU. The results are included in Appendix C.

Alum was used in the coagulation/flocculation/sedimentation testing, followed by filtration through a 1.2 µm membrane which, in our experience, emulates the performance of a dual media filter. The results of the testing demonstrate that filtration down to a turbidity of <0.1 NTU is achievable with the appropriate alum dosage.

ALUMINUM RESIDUAL

The use of aluminum salt coagulants (alum, polyaluminum chloride, etc.) in potable water treatment plants may lead to increased aluminum concentrations in treated water, which may result in water quality and supply problems.

There is no evidence that aluminum is physiologically harmful, and no health-related limit has specified anywhere in the world to our knowledge. However, the perception of potential health problems associated with aluminum frequently emerges.

Water supply problems may be associated with increased aluminum concentrations in treated water. These problems include the formation of a hydrous aluminum precipitate in the distribution system which may increase turbidity and complaints about clarity. Aluminum floc in the system may interfere with the disinfection process by entrapping and protecting microorganisms. Another problem attributed to increased aluminum concentrations is deposition of aluminum hydrolysis products on pipe walls, which decreases carrying capacity. To minimize these problems, the Ontario Drinking Water Objectives (ODWO) suggest an operational guideline of <0.1 mg/L as Al in the treated water leaving the plant.

An EPA survey of 186 utilities showed that a number of plants exhibited high residual aluminum when overdosing of alum occurred. Even though some utilities surveyed stated that minimizing the alum dosage is a strategy for controlling residual aluminum, underdosing of alum appears to be just as detrimental to turbidity removal and residual aluminum control as overdosing.

Water quality problems associated with high concentrations of aluminum in finished water have led to discussion of ways to reduce residual aluminum concentrations. One method of reducing aluminum concentration is to optimize coagulation. To have optimum coagulation requires that the best coagulant, dosage, and combination of operating conditions be selected for each raw water. The optimum pH range must also be achieved since aluminum is least soluble in water in the pH range 5.5-7.0.

There are treatment plants in Ontario which are currently using residual aluminum as an "operational tool" to optimize the dosge of alum. Operational staff respond to any elevation in residual aluminum and make the necessary adjustments to the plant operation.

(a) Jar Testing (cont'd)

Aluminum solubility in water is a complex topic; but some of the most significant variables are pH, time and temperature. For pH values greater than 6.5, the aluminum residual increases directly with pH. Aluminum residual is inversely proportional to time, up to several hours, whereupon the solubility concentration remains fairly constant. The aluminum residual is directly related to temperature, but this has a fairly minor impact over the ranges encountered in natural waters. For times greater than an hour and pH's greater than about 7.4, water may contain a residual concentration greater than 0.1 mg/L.

For the aluminum residuals and pH values found in the waters at the plant, the results are consistent with general experimentally determined values. Therefore, it is not surprising to find aluminum concentrations greater than 0.1 mg/L.

Cornwall's treated water aluminum residuals have sometimes been above the guideline of 0.1 mg/L, therefore, jar tests were run by the Ontario Ministry of the Environment to check aluminum residual. Preliminary Ministry results indicated an optimum alum dosage of 25 mg/L to produce a treated water aluminum residual of 0.04 mg/L. The use of polyaluminum chloride (PACl) as a coagulant was also tested in combination with various polyelectrolytes. The aluminum residual was reduced to 0.025 mg/L following treatment with 15 mg/L PACl and 0.5 mg/L Percol LT20 polymer. The Ministry believes more investigation is required to determine the optimum alum dosage. In Gore & Storrie's opinion, the benefits associated with changing the alum dosage to control the aluminum residual, over and above those for turbidity control, is not warranted.

A minimum of daily monitoring of aluminum residual and pH leaving the plant is recommended by the Ontario Ministry of the Environment. An acceptable method of aluminum analysis should be used. Frequent examination of this data and Drinking Water Surveillance Program (DWSP) data will supply the needed information on the chemistry and fate of aluminum following water treatment to help operating authorities minimize the concentration of aluminum in the treated water.

(a) Jar Testing (cont'd)

COAGULANT(S) DOSAGE

From the laboratory testing conducted by Gore & Storrie Limited, it appears that a minimum alum dosage of 5 to 15 mg/L is required.

E.3 Optimum Removal Strategies

(a) Coagulation

We recommend that alum or some other coagulant be added all of the time to ensure an effective treatment process. The dosage range for alum should be 5 to 15 mg/L.

(b) Flocculation, Mixing and Sedimentation

As noted earlier, the good raw water conditions at Cornwall would allow for treatment by direct filtration. Although the Cornwall plant was not originally designed for direct filtration, and does not have some of the specific direct filtration unit operations, Gore & Storrie believes the plant can operate in the direct filtration mode with the present raw water quality.

The overflow rate of 5.6 m/h at 100 ML/d is too high for a conventional horizontal settling tank, however, this is an acceptable rate since the plant could be operated in the direct filtration mode. The settling effectiveness does not have a significant impact on the overall effectiveness of the plant process.

(c) Filtration

The filters and the filtration rates are presently dictated by the demand for clearwell water. This procedure is stressful for the filters since any change of flow rate can reduce filter removal performance. Also, the lower the filtration rate, the better the removal performance; which can be achieved by operating all filters all the time. Therefore, from the standpoint of particulate removal, the ideal procedure would be to operate all filters with a constant flow rate to satisfy some long-term demand. This procedure requires that the clearwell level rise and fall to offset the difference between production and demand flow rates.

It is our opinion that tests should be carried out on plant scale to determine the magnitude of improvement which would result from maintaining lower constant flow rates. These results should be assessed in light of the operational considerations, such as the storage volume.

In order to optimize the performance of the plant, turbidimeters should be installed on the effluent of the filters.

SECTION F

PLANT PERFORMANCE (DISINFECTION)

SECTION F
PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection

At the Cornwall Water Treatment Plant, disinfection is carried out by chlorination at two points in the treatment process. The first application point is at the pre-mix chamber located between the screens and the flocculation tanks. Alum is also added to the pre-mix chamber. The chlorine is added to achieve a free residual of 0.1 mg/L in the filter effluent. Data from Tables 3.0 and 3.1 in Appendix A show that the monthly average pre-chlorine dosage ranged from 0.54 to 1.3 mg/L during the 1983 to 1986 period.

The second chlorine application point is between the clearwell and the high lift pumping station. Enough chlorine is added to maintain a free residual of 0.3 mg/L in the water leaving the plant. Data from Tables 3.0 and 3.1 show that the post-chlorine dosage ranged from 0.31 to 0.65 mg/L.

F.2 Disinfection Efficiency

Tables 7.0 to 7.5 in Appendix A summarize the available raw and treated microbiological data for the Cornwall Water Treatment Plant. Fecal coliforms, as well as total coliforms, were found in the raw water at levels in excess of guidelines, indicating that disinfection is necessary.

The data show that the microbiological quality of the water leaving the plant is good. From the testing conducted in the Ministry of the Environment Toronto laboratory, total coliforms were found in the treated water on five occasions during 1983 to 1986. Four results were one count per 100 mL, and one result was less than two counts per 100 mL. This meets the Ontario Drinking Water Objectives of less than five counts per 100 mL. The Ministry of the Environment Regional office bacteriological data also indicates that total coliforms were sometimes found in the treated water, but usually at levels of <5 counts per 100 mL. Only once during the period examined did the treated water total coliform count exceed 5 counts/100 mL. The majority of the Regional office test results, however, are distribution system samples, so this result may not have been a plant effluent sample.

In Gore & Storrie's opinion, the chlorine feed system and the operations policy for disinfection of the water are adequate, however, the Ministry of the Environment believes a coagulant should be added at all times to ensure removal of Giardia and Cryptosporidium. We recommend that testing for fecal coliforms and fecal streptococcus in the treated water be implemented on a regular basis.

F.3 Chlorinated By-Products

TRIHALOMETHANES

Trihalomethanes (THM's) are the most widely occurring organics found in drinking water, and they also appear at the highest concentrations. The principal source of THM's in drinking water is the chemical interaction of chlorine added for disinfection, with humic and fulvic substances that occur naturally in the raw water. There is some evidence that THM's are carcinogenic. The Ontario Drinking Water Objectives for THM's is 350 µg/L.

Based on the limited data available on THM's (see Table F.1) for the Cornwall Water Treatment Plant, the levels of THM's found in the treated water are under the Ontario Drinking Water Objectives of 350 µg/L (or 0.35 mg/L). Total THM values were assumed to be determined by the direct aqueous injection (DAI) method, which, for the treated water, ranged from 32 to 114 µg/L, with an average value of 63 µg/L. Values found during the summer were two or more times higher than those found during the winter. This variation could be the result of the higher temperature of the raw water and the higher chlorine dosage used during the summer months. It is our opinion that little should be done, at this time, to assess methods of reducing the THM's to lower levels.

TOTAL ORGANIC HALIDES

The terms of reference require consideration be given to the reduction of chlorinated by-products in the treated water. There was no complete set of information on the total concentrations of all organohalogen compounds.

F.3 Chlorinated By-Products (cont'd)

It is our opinion that a broader measurement of chlorinated by-products should be considered and possibly a surrogate measurement should be utilized. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

TABLE F.1
Trihalomethane Data for Cornwall WTP

		1985		
		R	T	D
JAN	Chloroform	ND	16	18
FEB	($CHCl_3$)	ND	18	12
MAR				
APR				
MAY				
JUN		ND	107	111
JUL				
AUG		ND	30	
SEP				
OCT				
NOV				
DEC				
JAN	Bromodichloromethane	ND	13	
FEB	($CHBrCl_2$)	ND	11	
MAR				
APR				
MAY				
JUN		ND	7	
JUL				
AUG		ND	18	
SEP				
OCT				
NOV				
DEC				
JAN	Chlorodibromomethane	ND	5	
FEB	($CHBr_2Cl$)	ND	6	
MAR				
APR				
MAY				
JUN		ND	0	
JUL				
AUG		ND	22	
SEP				
OCT				
NOV				
DEC				
JAN	Bromoform			
FEB	($CHBr_3$)			
MAR				
APR				
MAY				
JUN				
JUL				
AUG				
SEP				
OCT				
NOV				
DEC				

TABLE F.1 (cont'd.)

		1985		
		R	T	D
JAN	Total THM's		32	35
FEB			37	24
MAR				
APR				
MAY				
JUN			114	117
JUL				
AUG			70	
SEP				
OCT				
NOV				
DEC				
AVG.			63	59
RNG.			32-114	24-117

R = Raw Water
T = Treated Water
D = Distributed Water

SECTION G

SHORT AND LONG-TERM MODIFICATIONS

SECTION G
SHORT AND LONG-TERM MODIFICATIONS

G.1 Description

(a) General

This section includes feasible short and long-term process modifications required to approach optimum disinfection and particulate removal. It is important to understand that optimization of selected process steps may be in conflict with other aspects of the plant, such as staffing and budgeting costs.

The 1988 "City of Cornwall Water Purification Plant - Master Plan Study" by Simcoe Engineering Limited identified the following capital improvements:

- Baffling in settling tank area,
- Interconnection of high lift discharge headers external to plant,
- Necessary changes for flocculation tank area,
- Proposed bypass for raw water intake valve,
- Removal of conduits between settling tank and filter conduit and necessary structural changes,
- Change of filter media in Filters 1 and 2,
- Replacement of diesel generator set,
- Calibration of all in-plant meters,

The course of action to deal with the above matters is being decided outside the Terms of Reference for this study.

The following short and long-term recommendations were provided, discussed, reviewed, and agreed upon at the plant site meeting.

We have assigned costs for each of the recommended works. These costs may be reduced if the City carries out the work.

G.2 Flash Mixing

There is a concrete chamber (part of screen chamber) at the Cornwall Water Treatment Plant that provides minimal chemical mixing. It has a theoretical detention time of 86 seconds at 100 ML/d, and 191 seconds at 45 ML/d.

It is recommended that detailed laboratory and plant-scale tests be conducted to determine the value of flash mixing for the various flow and water quality conditions at this plant. If the tests document the merits of flash mixing, install a flash mixer in the concrete chamber.

This work could be carried out any time. The cost of the study would be $10,000 to $15,000. The cost of the flash mixer would be $25,000 to $35,000.

G.3 Coagulant Addition

In the past, there have been periods of time when alum has not been added to the water due to operating budget restraints. There had been a tendency in the water treatment industry, in the past, to stop using alum during periods of low raw water turbidity. This practice does not allow the plant process components to effectively remove particulate material such as turbidity and cysts of certain micro-organisms such as Giardia Lamblia.

It is recommended that a coagulant be added all of the time to ensure an effective treatment process.

This recommendation should be implemented immediately. The total cost per year would be approximately $50,000, based on a dosage of 10 mg/L and an average flow of 45 ML/d.

G.4 Alum Pump Calibration

The ease and accuracy of metering pump calibration and confirmation of actual set dosages is vital to the optimum operation of a coagulant feed system.

G.4 Alum Pump Calibration (cont'd)

Tests should be conducted to assess the changes in calibration; if it is found that the calibration changes quickly, then consideration should be given to the installation of graduated containers on the suction side of each alum metering pump. The pumps should be calibrated regularly against the stroke position. The pumps are presently calibrated every month.

This recommendation should be implemented immediately on the existing alum pumps and should be included with any future coagulant metering pump installation. The cost to install the graduated containers is about $300 per pump.

G.5 Coagulant Aids

Laboratory testing and plant operating records have demonstrated the effectiveness of various coagulant aids to improve the filtered water quality. Coagulant aids generally enable a plant to achieve lower treated water turbidities.

It is recommended that Cornwall continue to perform laboratory studies to pre-screen the various polyelectrolytes available. Previous test results should be reviewed, summarized and catalogued into one document.

A plant-scale pilot program should be conducted over a one-year period using the preferred polyelectrolytes as coagulant aids. The coagulant aid testing should be carried out after decisions have been made on the installation of a flash mixer.

The cost for equipment to carry out this work is $30,000, and the cost of the chemical is $5,000 to $10,000 for a one year test.

G.6 Isolation of Flocculation Tanks

Since the level of mixing in the flocculation tanks is proportional to the flow rate, there may be some benefit obtained by shutting off groups of flocculation tanks. The isolation of the flocculation tanks also isolates the associated settling tanks. There is concern over freezing occurring in the isolated tanks. Throttling is an alternative which would maintain low flows through the sedimentation tanks and solve the problem of icing.

It is recommended that the operation of the flocculation tanks at various flow rates be compared.

This plant-scale work should be carried out during periods when the overall plant flows are lower. The cost of this recommendation is minimal.

G.7 Filter Performance Evaluation

Filters 1 and 2 contain multi-media as supplied by Neptune Microfloc, and Filters 3 and 4 contain conventional sand and anthracite dual media.

It is recommended that tests be conducted on the various filters to determine their relative performances. The tests should examine the process capacity, length of filter run, headloss accumulation, and filter effluent quality.

This work could be carried out at any time. The cost of this study would be $10,000 to $15,000.

G.8 Filtration Rates

Filtration rates are presently dictated by the demand for clearwell water. This procedure causes changes of flow rate and can reduce the filters' particulate removal capability.

It is recommended that plant scale tests be carried out on the filters to determine the magnitude of improvement which would result from maintaining lower constant filter flow rates. One aspect to be studied is the lowest filter flow rate that must be maintained for the flow controllers to work.

G.8 Filtration Rates (cont'd)

The plant scale tests could commence immediately and should extend over various seasons. The cost of this work would be minimal since the majority of the data will be readily available to the plant staff. An allowance of $5,000 should be made to interpret the information.

G.9 Filter Effluent Turbidimeters

Elevated plant effluent turbidities can be minimized or eliminated by monitoring individual filter effluent turbidities. The problem filter can be identified and backwashed before the plant effluent turbidity rises.

To optimize the plant particulate removal performance, it is recommended that turbidimeters be installed on the effluents of all four filters.

This work should be carried out as soon as possible. The cost for four turbidimeters would be $10,000 to $15,000.

G.10 Filter Media Characteristics

The characteristics of filter media can change with time. Media can be lost during backwashing and, in some instances, media can escape through support systems and end up in the clearwell. The anthracite media actually breaks up by mechanical abrasion over a period of time. Another filter problem is the upset of the gravel layer.

It is recommended that the following tests be conducted:

- Sieve analysis and grain size characterization on each filter once every five years.

- The distance from the filter walkway to the top of the media for each filter should be measured and recorded each year. This measurement should be carried out at four locations in each filter immediately after placing the filter back on line following a backwash.

- The distance from the filter walkway to the top of the gravel layer at a minimum of four locations in each filter should be measured and recorded each year. This measurement should be taken immediately after fluidization of the filter bed during a low wash rate.

These records become an early warning of media problems.

This recommendation should be implemented as soon as possible. The work should be carried out by Cornwall staff and the costs will be minimal.

G.11 Emergency Backwash System

If the backwash pump is out of service, it is possible to backwash the filters using flow from the high lift pumps.

This type of operation may cause filter disruption problems if the flow is too great. It is recommended that the emergency backwash system be examined to evaluate the potential for filter disruption.

The recommendation can be implemented at any time. The work should be carried out by Cornwall staff and costs will be minimal.

G.12 Filtered Water Flow Metering

Each of the four filters is metered separately with a venturi. The filter rate controllers were replaced with larger venturi meters and filter flow rate control valves to increase the capacity of the filters.

It is recommended that a detailed investigation to determine the flow ranges of each venturi meter be conducted.

This work could be carried out any time. The cost for this study would be approximately $3,000.

G.13 Turbidity Profile

A turbidity profile through a plant is a useful operating tool, and provides a good set of data for the purpose of plant performance review. This profile indicates the effects of changing conditions on specific operations through the process.

It is recommended that a Turbidity Profile for the raw, settled, filtered and plant effluent water be recorded. The profile should be recorded once every four hours as a minimum.

This recommendation can be implemented as soon as possible. The cost is minimal.

G.14 Bacteriological Testing

Plant effluent and samples from the two reservoirs are analyzed for total coliforms once a week by the Ministry of the Environment lab in Toronto. The Regional Ministry of the Environment lab in Kingston also conducts total coliform tests on the plant effluent and several distribution system samples once a week.

It is recommended that the treated water be tested for fecal coliforms and fecal streptococcus on a regular basis.

This recommendation should be implemented as soon as possible.

G.15 Chlorinated By-Products

It is our opinion that a broader measurement of chlorinated by-products should be considered. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

It is recommended that the Province of Ontario develop a surrogate for organics.

G.16 Record of Information

The nature, frequency, and arrangement of information recorded about plant operations is vital to the operation and management of a water treatment plant.

The Cornwall Plant has a computer system, and the WPOS tables could be stored on disk. It is recommended that this information be kept at the plant and continuously updated.

The Plant's record of information should also include the following:

- Process and piping diagram (PAPD)*
- Filter media characteristics
- Drawings
- Any data to be used in the future for operation of the Plant or design purposes.

* A process and piping diagram should be developed to include all of the piping changes made over the years. It is recommended that it be stored on a CADD system for the ease of updating.

G.17 Per Capita Consumption

At the present time, the Cornwall Plant metering system requires improvements in its accuracy, and therefore, may elevate the per capita flow data. Leakage in the system may also elevate the calculated per capita consumption valves.

It is recommended that the per capita flows be examined further when the above situations are rectified.

APPENDIX A

TABLES

TABLE 1.0: FLOWS (ML/d)

CORNWALL WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	52.1	34.4	42.0	36.5	29.5	33.9	41.6	33.0	37.1	39.4	28.1	33.2
	T	51.3	33.7	41.3	35.9	29.0	33.3	41.3	32.4	36.4	35.5	15.7	32.6
FEB	R	44.3	36.0	39.9	37.6	30.1	34.2	46.9	32.4	37.2	42.3	24.8	37.1
	T	43.7	35.3	39.3	33.9	29.6	33.6	46.2	31.8	36.6	38.2	19.4	36.5
MAR	R	45.0	38.8	41.4	49.1	28.4	37.7	46.1	32.6	37.3	39.4	32.7	36.6
	T	44.6	38.2	40.8	48.0	28.4	36.8	45.5	32.1	36.8	ND	ND	ND
APR	R	50.1	37.9	42.9	38.8	28.8	34.3	47.4	32.8	35.5	39.4	27.5	33.9
	T	49.4	37.2	42.3	38.2	27.5	33.2	46.8	32.2	34.9	ND	ND	ND
MAY	R	54.4	32.7	44.8	47.9	28.1	37.0	53.6	31.8	42.7	55.6	28.7	34.9
	T	53.2	31.9	42.6	47.0	27.4	36.0	52.8	31.1	41.9	30.8	14.7	24.0
JUN	R	58.8	39.1	47.7	50.7	34.1	39.9	60.4	38.5	47.9	61.8	31.9	44.0
	T	58.0	38.7	47.2	49.1	33.3	39.1	59.2	37.5	47.0	(56.8)	18.2	35.11
JUL	R	60.4	36.0	49.4	58.3	38.6	45.2	66.3	39.2	52.0	61.9	40.3	48.01
	T	(58.8)	35.3	48.4	57.2	37.5	44.4	65.8	38.0	51.3	54.6	20.7	38.7
AUG	R	57.1	42.0	49.2	59.4	34.0	48.9	74.1	36.0	49.0	53.3	35.5	42.1
	T	55.6	41.0	48.2	(58.3)	33.4	47.9	(73.9)	35.3	48.3	46.8	20.0	32.1
SEP	R	51.7	41.4	46.8	43.1	32.2	38.4	43.6	31.5	37.8	58.4	33.2	42.1
	T	50.5	49.9	44.3	42.2	31.4	37.6	43.1	30.9	37.3	51.4	13.1	28.1
OCT	R	49.7	40.2	44.0	39.4	28.2	34.9	49.1	30.4	36.8	40.2	30.0	35.1
	T	49.0	36.6	42.6	39.5	27.5	33.7	48.6	29.7	36.1	23.6	10.4	ND
NOV	R	46.0	38.7	42.5	39.4	30.4	34.5	38.9	31.4	33.8	38.1	31.2	34.9
	T	45.4	38.0	41.8	38.6	29.7	33.9	38.4	30.7	33.2	20.8	11.8	ND
DEC	R	53.3	40.1	46.2	40.5	29.4	35.3	38.0	29.2	33.9	40.5	32.4	36.0
	T	51.9	39.1	45.2	40.1	28.7	34.6	37.7	28.6	33.3	24.6	11.7	ND

Note: Brackets indicate maximum day for the year. Flows are measured with venturi meters.
Reliability of flow measurements is discussed elsewhere in this report.
ND indicates no data available.

TABLE 1.1: PER CAPITA CONSUMPTION (L/DAY/CAPITA)

WPOS CORNWALL WTP

	1986	1985	1984
POP.(1)	45,980	45,980	45,906
MAX.	1279	1268	1610
MIN.	694	596	623
AVG.	950	805	858
MD/AD	1.35	1.58	1.88

MD/AD = Maximum Day/Average Day

(1) Population data obtained from City Clerk's office, Cornwall.
Per Capita Consumption for 1983 is not recorded due to unreliable flow data.
No equivalent population figures were used for commercial base.

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

WPOS - CORNWALL WTP

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (FTU)		R			1.3			1.5			1.0			0.70
			T			0.33			0.40			1.0			1.8
	Alum	(mg/L)				2.4(1)			3.4						
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T			0.029(2)			0.183(3)						
	pH		R									7.9			8.1
			T									7.4			7.8
	Temperature	(^{o}C)				3.1			2.4			2.0			1.9
FEB	Turbidity (FTU)		R			1.7			2.0			0.30			1.00
			T			0.38			0.50			0.50			0.50
	Alum	(mg/L)							3.5						
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R									7.7			7.9
			T									7.7			7.7
	Temperature	(^{o}C)				3.1			2.5			2.0			1.0
MAR	Turbidity (FTU)		R			0.53			0.70			1.0			1.30
			T			0.54			0.20			0.60			0.46
	Alum	(mg/L)							3.3						
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T						0.205(3)						
	pH		R									8.0			8.1
			T									7.7			7.7
	Temperature	(^{o}C)				3.1			3.2			2.0			

- Blanks indicate no tests performed or no chemical added.
- See notes at end of Table 2.0 for method of data collection, analysis and frequency.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Turbidity (FTU)		R			0.52			0.80			0.84			3.30
			T			0.38			0.30			0.56			0.53
	Alum	(mg/L)				3.0(4)			3.2						
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T						0.229(2)			0.237(8)			
	pH		R			8.1						8.0			8.0
			T			7.8						7.5			7.8
	Temperature	(°C)				6.8			5.2			4.5			4.4
MAY	Turbidity (FTU)		R			0.63			0.55			0.80			0.59
			T			0.40			0.40			0.74			0.63
	Alum	(mg/L)		4.9	2.1	3.2			4.0			5.4			
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T			0.283(7)			0.456(2)			0.379(2)			
	pH		R			7.6						8.1			7.9
			T			7.7						7.8			7.7
	Temperature	(°C)		15.0	9.5	11.5			11.0			9.3			9.2
JUN	Turbidity (FTU)		R						2.20			1.0			0.95
			T						0.40			0.71			0.30
	Alum	(mg/L)		4.3	1.0	3.6(5)			5.8(4)			5.8			17.2(6)
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T						0.308(2)						0.077(9)
	pH		R									7.8			8.0
			T									7.6			7.6
	Temperature	(°C)				15.7			15.5			15.7			15.5

- See note at end of Table 2.0 for method of data collection, analysis and frequency.

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (FTU)		R			0.75	2.5	0.41	0.81			0.62			0.80
			T			2.1	0.84	0.09	0.25			0.45			0.20
	Alum	(mg/L)		8.9	1.4	7.6(10)	7.7	2.3	7.6			5.0			18.7
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T			0.081(12)						0.293(12)			0.020(13)
	pH		R			8.1						8.1			7.7
			T			7.5						7.7			7.4
	Temperature	(^{o}C)		22.0	17.0	19.6			19.8			20.5			21.0
AUG	Turbidity (FTU)		R			0.90			2.50			2.1			2.00
			T			0.38			0.20			0.41			0.37
	Alum	(mg/L)		11.9	1.3	8.7(11)			3.3			4.3			14.2
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T			0.173(12)			0.290(12)						0.16[illegible](12)
	pH		R			8.2						8.1			7.9
			T			7.9						7.7			7.5
	Temperature	(^{o}C)		22.0	20.0	21.4			22.3			22.5			22.9
SEP	Turbidity (FTU)		R			0.73			1.0			0.33			1.5
			T			2.7			0.40			0.36			0.23
	Alum	(mg/L)		11.5	10.4	11.1			3.3			3.2			11.8
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T						0.248(12)			0.360(12)			0.213(12)
	pH		R			8.2						7.5			8.0
			T			7.5			7.5			7.6			7.4
	Temperature	(^{o}C)		20.0	17.5	18.5			19.5			19.2			21.0

- See notes at end of Table 2.0 for method of data collection, analysis and frequency.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Turbidity (FTU)		R			1.6			1.0			1.8			3.4
			T			0.28			0.40			0.35			0.49
	Alum	(mg/L)		15.1	6.3	10.4			3.3						9.2(14)
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T			0.077(12)			0.273(12)						
	pH		R			8.2						8.4			7.7
			T			7.5						7.8			7.7
	Temperature	(°C)		17.0	13.0	14.0			16.1			16.0			16.4
NOV	Turbidity (FTU)		R									0.82			1.3
			T									0.44			0.61
	Alum	(mg/L)							3.5			3.4			
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T						0.173(16)			.138(15)			
	pH		R									8.1			7.8
			T									7.8			7.6
	Temperature	(°C)							11.0			11.1			9.8
DEC	Turbidity (FTU)		R						1.8						1.0
			T									0.30			0.66
	Alum	(mg/L)							3.3			3.2			
	Coagulant Aid	(mg/L)													
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R												7.9
			T						7.7						7.6
	Temperature	(°C)							5.5			6.1			4.0

- See note at end of Table 2.0 for method of data collection, analysis and frequency.

NOTES: TABLE 2.0

All turbidity and pH measurements were performed at the MOE lab, Resources Road, Rexdale, Ontario. Raw and treated water samples are collected in the Cornwall WTP lab and sent to the MOE lab for analysis once a month. The lab in the Cornwall plant is equipped with a Hach 2100A turbidimeter. Prior to September 1986, samples of raw and treated water were checked for turbidity by the plant operators but not recorded in a regular or consistent fashion. The daily log sheets were changed in September 1986 to accommodate daily turbidity readings.

In addition to metering pumps, alum dosage is verified by level readings of the alum tank. This reading is taken daily and recorded as IG/d on the daily log.

Tests for residual aluminium have been done quite frequently as a result of the Cornwall plant's history of exceeding the Provincial guidelines for this parameter.

(1) 7 days no alum added. Average displayed is for days which alum was added.
(2) Average of 2 tests; each one for filter effluents 1-3.
(3) Average of 4 tests; each one for filter effluents 1-4.
(4) 2 days no alum added. Average displayed is for days which alum was added.
(5) 21 days no alum added. Average displayed is for days which alum was added.
(6) 22 days no alum added. Average displayed is for days which alum was added.
(7) Average of 3 tests; each one for filter effluents 2,3,4.
(8) Average of 3 tests; each one for filter effluents 1,3,4.
(9) Average of 3 tests; each one for filter effluents 1,2,4.
(10) 11 days no alum added. Average displayed is for days which alum was added.
(11) 2 days no alum added. Average displayed is for days which alum was added.
(12) Average of 4 tests; each one for filter effluents 1,2,3,4.
(13) Average of 3 tests; each one for filter effluents 1,2,3.
(14) Alum off 22 days. Average displayed is for days which alum was added.
(15) Average of 2 tests; each one for filter effluents 1,2,3 and 4.
(16) Average of 3 tests; each one for filter effluents 1,2,4.

TABLE 2 1: PARTICULATE REMOVAL PROFILE (JULY/1985)

WPOS - CORNWALL WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/l	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1												
2												
3	1.10			0.14	6.2							
4												
5	0.80			0.18	6.6							
6												
7												
8	0.25			0.12	6.6							
9	0.64			0.14	6.9							
10	0.41			0.14	2.3							
11	0.91			0.36	6.0							
12												
13												
14												
15	0.95			0.18	7.4							

TABLE 2 1 (cont'd.)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP. (^{0}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	0.78			0.11	6.9							
17	0.75			0.10	6.4							
18	0.65			0.11	7.7							
19	0.81			0.10	6.1							
20												
21												
22	2.50			0.40	6.0							
23												
24												
25	0.91			0.84	2.8							
26	0.54			0.09	6.7							
27												
28												
29	0.89			0.61								
30												
31												

Notes: Above data recorded by plant only during July 1985 as a special case. Prior to September 1986, daily turbidity readings were not recorded.

No data available for blank columns.

TABLE 3.0: DISINFECTION SUMMARY

Page 1 of 4

WPOS CORNWALL WTP

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage			0.58			0.31			0.71			0.38
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
FEB	Cl_2 Demand												
	Cl_2 Dosage			0.54			0.31			0.71			0.36
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
MAR	Cl_2 Demand												
	Cl_2 Dosage			0.55			0.32			0.63			0.32
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

- Chlorine dosage is verified by weigh scale readings of chlorine cylinders. This reading is taken daily.

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage			0.59			0.38			0.57			0.38
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
MAY	Cl_2 Demand												
	Cl_2 Dosage	0.84	0.56	0.75	0.51	0.28	0.49			0.88			0.45
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
JUN	Cl_2 Demand												
	Cl_2 Dosage	0.99	0.58	0.89	0.50	0.28	0.56			0.83			0.51
	Ammonia												
	SO_2			0.1			0.3			0.1			0.3
	Resid. Cl_2 Free												
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	1.11	0.44	0.96	0.56	0.34	0.53			0.99			0.54
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
AUG	Cl_2 Demand												
	Cl_2 Dosage	1.23	0.78	0.94	0.60	0.38	0.48			1.00			0.52
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
SEP	Cl_2 Demand												
	Cl_2 Dosage	0.88	0.63	0.77	0.55	0.37	0.50			1.01			0.55
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage	0.89	0.64	0.72	0.33	0.33	0.45			0.88			0.46
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
NOV	Cl_2 Demand												
	Cl_2 Dosage									0.81			0.43
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
DEC	Cl_2 Demand												
	Cl_2 Dosage									0.65			0.35
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

TABLE 3.1: DISINFECTION SUMMARY

WPOS - CORNWALL WTP

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage			0.69			0.36			0.74			0.39
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
FEB	Cl_2 Demand												
	Cl_2 Dosage			0.67			0.34			0.70			0.37
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
MAR	Cl_2 Demand												
	Cl_2 Dosage			0.67			0.34			0.75			0.38
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

- Chlorine dosage is verified by weigh scale readings of chlorine cylinders. This reading is taken daily.

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage			0.72			0.38			0.78(1)			0.41(1)
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
MAY	Cl_2 Demand												
	Cl_2 Dosage			0.87			0.45			0.93			0.48
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
JUN	Cl_2 Demand												
	Cl_2 Dosage			1.13			0.57			1.08			0.56
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

(1) Cl_2 off April 1-5th and 15-17th.

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage			1.17			0.60			1.18			0.60
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
AUG	Cl_2 Demand												
	Cl_2 Dosage			1.11			0.57			1.28			0.65
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
SEP	Cl_2 Demand												
	Cl_2 Dosage			1.04			0.53			1.14			0.60
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage			1.02			0.53			1.02			0.53
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
NOV	Cl_2 Demand												
	Cl_2 Dosage			0.96			0.51			0.91			0.46
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												
DEC	Cl_2 Demand												
	Cl_2 Dosage			0.79			0.42			0.79			0.41
	Ammonia												
	SO_2												
	Resid. Cl_2 Free			0.1			0.3			0.1			0.3
	Resid. Cl_2 Comb.												
	Resid. Cl_2 Total												

TABLE 4.0: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION SUMMARY

WPOS - CORNWALL WTP

		1986			1985			1984			1983		
		MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.
JAN	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.			1.0			1.5			1.4			1.0
FEB	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.			1.1			0.2*			1.0			1.0
MAR	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.			1.25	0.88	1.33	1.0			1.1			1.3
APR	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.			0.83	1.05	1.3	1.2			1.1			1.2
MAY	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.			0.95	0.90	1.22	1.0			1.1			1.2
JUN	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.					1.41	1.3			1.0			1.1

* Fluoride machine not working

TABLE 4.0 (cont'd.)

		1986			1985			1984			1983		
		MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.
JUL	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.						1.02			0.89(2)			
	F Res.			1.25	1.18	1.33	1.2			0.97			1.1
AUG	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	0	2.39	1.14(1)			0.97			0.98(3)			
	F Res.			1.0			1.1			1.0			1.2
SEP	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.	0	1.7	0.79(8)			1.16			1.00(4)			
	F Res.			0.84			1.2			1.3			1.2
OCT	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.									1.23(5)			
	F Res.			0.78						1.4			1.2
NOV	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.									1.57(6)			
	F Res.									1.1			1.3
DEC	PAC												
	$KMnO_4$												
	Lime												
	Soda Ash												
	F Dos.									1.95(7)			
	F Res.						1.2						1.4

NOTES: TABLE 4.0

(1) No F added 8, 11, 13, 14, 19, 20, 21, 23, and 24

(2) No F added 1st-9th.

(3) F added 26th-31st only.

(4) No F added 25th-31st.

(5) F added 12th-30th only.

(6) No F added 2nd-8th.

(7) No F added 17th, 19th-31st.

(8) No F added 8, 11, 13, 14, 19-22, 23, and 24

Fluoride residual is measured at the Cornwall Plant. A continuous fluoride residual analyser is in use at the Cornwall plant. Fluoride dosages are verified by level readings of the hydrofluosilicic acid tank. This reading is supposed to be taken daily; however, it is apparent that this is not done on a regular basis. For example: according to the daily logs and monthly summaries, no fluoride was added in 1983. However, the fluoride residual for the year for the treated water averaged 1.2 mg/L, much higher than the raw water fluoride level. Other examples of this are obvious in Table 4.0.

TABLE 5.0: WATER QUALITY (FOUR-YEAR SUMMARY)

WPOS - CORNWALL WTP

GENERAL CHEMISTRY		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
GENERAL CHEMISTRY -(A)															
Alkalinity (mg/L)	R	99	91	95	102	89	96(1)	100	96	98(3)	98.5	93.2	95.2	0.2 (mg/L)	
	T	98	83	90	100	90	94	92	89	90	99.9	86.2	88.8		
Ammonium (Total) (mg/L)	R													0.05 (mg/L)	
	T														
Calcium (mg/L)	R													0.1 (mg/L)	
	T														
Chloride (mg/L)	R	30	26	28	28	24	26(2)			25				0.2 (mg/L)	250 (mg/L)
	T	31	27	29	29	25	27	27	26	26(3)					
Colour (TCU)	R	15	3	8	10	2	7	18	2	9	15	5	8	0.5 (TCU)	5 (TCU)
	T	5	2	3	7	1	3	7	1	3	5	1	2		
Conductivity (umho/cm)	R	320	306	315	315	305	312	330	300	312	320	294	308	0.01 (umho/cm)	
	T	326	309	318	325	310	317	330	305	318	326	304	317		
Field Chlorine (Combined)	R													0.1 (mg/L)	
	T														
Field Chlorine (Free)	R													0.1 (mg/L)	
	T														
Field Chlorine (Total)	R													0.1 (mg/L)	
	T														
Field pH	R													0.2	
	T														

(A) General Chemistry test results were obtained from the monthly MOE chemical testing program. Bacteriological testing is carried out once per week by the MOE.

TABLE 5.0 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Field Temperature (°C)	R														
	T														
Field Turbidity (FTU)	R														1 (FTU)
	T														
Fluoride (mg/l)	R	0.22	0.15	0.19	0.20	0.19	(4) 0.16	0.30	(7) 0.10	0.21	0.31	0.13	0.19	0.01 (mg/l)	2.4 (mg/l)
	T	1.4	1.0	1.2	1.40	0.97	1.13	1.5	0.20	1.1	1.25	0.78	1.0		
Hardness (mg/L)	R	131	122	127	132	119	(5) 127	134	125	130(3)				0.5 (mg/l)	
	T	133	122	128	132	129	128	135	125	130					
Magnesium (mg/L)	R				8.9	7.4	8.7	8.0	8.0	8.0				0.05 (mg/L)	
	T				9.0	7.7	8.3	8.0	8.0	8.0					
Nitrate (mg/L)	R													0.05 (mg/L)	10 (mg/L as N)
	T														
Nitrite (mg/L)	R													0.005 (mg/L)	1 (mg/l as N)
	T														
Nitrogen Total Kjeldahl (mg/l)	R													0.1 (mg/l)	0.15 (mg/l)
	T														
pH	R	8.1	7.7	7.9	8.4	7.5	(6) 8.0	8.3	8.2	8.2(3)	8.22	7.64	8.07		
	T	7.8	7.4	7.6	7.8	7.4	7.7	7.7	7.5	7.6	7.92	7.46	7.66		
Phosphorus Filtered R active (mg/L)	R													0.01 (mg/l)	
	T														

TABLE 5.0 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Phosphorus (Total) (mg/L)	R													0.01 (mg/L)	
	T														
Sodium (mg/L)	R										12.0	11.9	12.0	0.1 (mg/L)	
	T												12.8		
Total Solids (mg/L)	R													1 (mg/L)	
	T														
Turbidity (FTU)	R	3.4	0.59	1.5	2.1	0.30	0.96	2.5	0.7	1.4	1.7	0.52	0.96	0.01 (FTU)	1 (FTU)
	T	1.80	0.20	0.56	1.0	0.30	0.58	0.5	0.2	0.3	2.7	0.33	0.83		
METALS															
Aluminum (mg/L)	R													0.003 (mg/L)	0.100 (mg/l) G
	T	0.230	0.020	0.117	0.420	0.033	0.279	0.530	0.001	0.237	0.310	0.027	0.129		
Arsenic (mg/L)	R													0.001 (mg/L)	0.05 (mg/L)
	T														
Barium (mg/L)	R													0.001 (mg/L)	1 (mg/L)
	T														
Beryllium (mg/L)	R													0.001 (mg/L)	
	T														
Boron (mg/L)	R													0.02 (mg/L)	5 (mg/L)
	T														
Cadmium (mg/L)	R													0.0003 (mg/L)	0.005 (mg/L)
	T														

TABLE 5.0 (cont'd.)

METALS (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Chromium (mg/L)	R													.001 (mg/L)	0.05 (mg/L)
	T														
Cobalt (mg/L)	R													0.001 (mg/L)	
	T														
Copper (mg/L)	R													0.001 (mg/L)	1 (mg/L)
	T														
Cyanide (mg/L)	R													0.001 (mg/L)	0.2 (mg/L)
	T														
Iron (mg/L)	R	0.85	0.05	0.20	1.40	0.05	0.21	0.20	0.10	0.16				0.002 (mg/L)	0.3 (mg/L)
	T	0.70	0.05	0.08	1.3	0.05	0.07	0.05	0.05	0.05					
Lead (mg/L)	R													0.003 (mg/L)	0.05 (mg/L)
	T														
Manganese (mg/L)	R													0.001 (mg/L)	0.05 (mg/L)
	T														
Molybdenum (mg/L)	R													0.001 (mg/L)	
	T														
Mercury (ug/L)	R													0.01 (ug/L)	1 (ug/L)
	T														
Nickel (mg/L)	R													(mg/L)	
	T														

TABLE 5.0 (cont'd.)

METALS (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Selenium (mg/L)	R													0.001 (mg/L)	0.01 (mg/L)
	T														
Strontium (mg/L)	R													0.001 (mg/L)	
	T														
Tin (no units available)	R														
	T														
Uranium (mg/L)	R													0.002 (mg/L)	0.02 (mg/L) t
	T														
Vanadium (mg/L)	R													0.001 (mg/L)	
	T														
Zinc (mg/L)	R													0.001 (mg/L)	5 (mg/L) h
	T														
PURGEABLES															
Benzene (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														
Bromoform (ug/L)	R													1 (ug/L)	350 (ug/L) ++
	T														
Carbon Tetrachloride (ug/L)	R													1 (ug/L)	3 (ug/L) h
	T														
Chlorobenzene (ug/L)	R													1 (ug/L)	100-300 (ng/L) h*
	T														

TABLE 5.0 (cont'd.)

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]	
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG			
Chlorodibromomethane	R							-	-	-				1	350	
(ug/L)	T							22	-	9(8)				(ug/L)	(ug/L)	++
Chloroform	R							-	-	-				1	350	
(ug/L)	T							107	16	43(8)				(ug/L)	(ug/L)	++
1,2-Dichlorobenzene	R													1	400	
(ug/L)	T													(ug/L)	(ug/l)	e
1,3-Dichlorobenzene	R													1	400	
(ug/L)	T													(ug/l)	(ug/L)	e
1,4-Dichlorobenzene	R													1	400	
(ug/L)	T													(ug/l)	(ug/l)	e
Dichlorobromomethane	R							-	-	-				1	350	
(ug/L)	T							18	7	12				(ug/L)	(ug/L)	++
1.1 Dichloroethane	R													1		
(ug/L)	T													(ug/l)		
1,2-Dichloroethane	R													1	10	
(ug/L)	T													(ug/L)	(ug/l)	h
1,1-Dichloroethylene	R													1	0.3	
(ug/L)	T													(ug/l)	(ug/l)	h
T,1,2-Dichloroethylene	R													1		
(ug/L)	T													(ug/L)		

TABLE 5.0 (cont'd.)

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Dichloromethane (ug/L)	R													5 (ug/L)	40 (ug/L)
	T														
1,2-Dichloropropane (ug/L)	R													1 (ug/L)	
	T														
Ethylbenzene (ug/L)	R													1 (ug/L)	1400 (ug/L)
	T														
Ethylene Dibromide (ug/L)	R														
	T														
M-Xylene (ug/L)	R													1 (ug/L)	620 (ug/L) c
	T														
O-Xylene (ug/L)	R													1 (ug/L)	620 (ug/L) c
	T														
P-Xylene (ug/L)	R													1 (ug/L)	620 (ug/L) c
	T														
Toluene (ug/L)	R													1 (ug/L)	100 (ug/L) c
	T														
1,1,2,2-Tetrachloroethane (ug/L)	R													1 (ug/L)	1.7 (ug/L) e
	T														
Tetrachloroethane (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														

TABLE 5.0 (cont'd.)

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,1,1-Trichloroethane (ug/L)	R													1 (ug/L)	1000 (ug/L) c
	T														
1,1,2-Trichloroethane (ug/L)	R													1 (ug/L)	6 (ug/L) e
	T														
Trichloroethylene (ug/L)	R													1 (ug/L)	30 (ug/L) h
	T														
Total Trihalomethanes (ug/L)	R							-	-	-				3 (ug/L)	350 (ug/L) ++
	T							114	32	63(8)					
Trifluorochloro-toluene (ug/L)	R													1 (ug/L)	
	T														
ORGANOCHLORINES															
Aldrin (ng/L)	R													1 (ng/L)	700 (ng/L) **
	T														
Alpha BHC (ng/L)	R													1 (ng/L)	700 (ng/L) c
	T														
Alpha Chlordane (ng/L)	R													2 (ng/L)	700 (ng/L) ***
	T														
Beta BHC (ng/L)	R													1 (ng/L)	300 (ng/L) c
	T														
Dieldrin (ng/L)	R													2 (ng/L)	700 (ng/L) **
	T														

TABLE 5.0 (cont'd.)

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Endrin	R													4	200
(ng/L)	T													(ng/L)	(ng/L)
Gamma Chlordane	R													2	700
(ng/L)	T													(ng/L)	(ng/L) ***
Heptachlor Epoxide	R													1	3000
(ng/L)	T													(ng/L)	(ng/L) ++
Heptachlor	R													1	3000
(ng/L)	T													(ng/L)	(ng/L) +++
Hexachlorobenzene	R													1	10
(ng/L)	T													(ng/L)	(ng/L) h
Hexachlorobutadiene	R													1	
(ug/L)	T													(ng/L)	
Hexachloroethane	R													1	19000
(ng/L)	T													(ng/L)	(ng/L) e
Lindane	R													1	4000
(ng/L)	T													(ng/L)	(ng/L)
Methoxychlor	R													5	100000
(ng/L)	T													(ng/L)	(ng/L)
Mirex	R													5	
(ng/L)	T													(ng/L)	

TABLE 5.0 (cont'd.)

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Octachlorostyrene	R													1	
(ng/L)	T													(ng/L)	
O,P-DDT	R													5	30000
(ng/L)	T													(ng/L)	(ng/L) d
Oxychlordane	R													2	
(ng/L)	T													(ng/L)	
PCB Total	R													20	3000
(ng/L)	T													(ng/L)	(ng/L) t
Pentachlorobenzene	R													1	74000
(ng/L)	T													(ng/L)	(ng/L) e
P,P-DDD	R													5	
(ng/L)	T													(ng/L)	d
P,P-DDE	R													1	
(ng/L)	T													(ng/L)	d
P,P-DDT	R													5	
(ng/L)	T													(ng/L)	d
1,2,3,4-Tetra-	R													1	
chlorobenzene (ng/L)	T													(ng/L)	
1,2,3,5-Tetra-	R													1	
chlorobenzene (ng/L)	T													(ng/L)	

TABLE 5.0 (cont'd.)

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,2,4,5-Tetra-chlorobenzene (ng/L)	R T													1 (ng/L)	38000 (ng/L) e
Thiodan I (ng/L)	R T													2 (ng/L)	74000 (ng/L) ea
Thiodan II (ng/L)	R T													4 (ng/L)	74000 (ng/L) ea
Thiodan Sulphate (ng/L)	R T													4 (ng/L)	
Toxaphene (no units available)	R T														
1,2,3-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
1,2,4-Trichlorobenzene (ng/L)	R T													5 (ng/L)	15000 (ng/L) y
1,3,5-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
2,3,6-Trichlorotoluene (ng/L)	R T													5 (ng/L)	
2,4,5-Trichlorotoluene (ng/L)	R T													5 (ng/L)	10000 (ng/L) g

TABLE 5.0 (cont'd.)

TRIAZINES		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
TRIAZINES															
2,6,A-Trichlorotoluene	R													5	
(ng/L)	T													(ng/L)	
Alachlor	R														
(ng/L)	T														
Ametrine	R													50	
(ng/L)	T													(ng/L)	
Atratone	R													50	
(ng/L)	T													(ng/L)	
Atrazine	R													50	46000
(ng/L)	T													(ng/L)	(ng/L) !
Bladex	R													100	10000
(ng/L)	T													(ng/L)	(ng/L) !
Metolachlor	R														
(ng/L)	T														
Prometone	R													50	
(ng/L)	T													(ng/L)	
Prometryne	R													50	1000
(ng/L)	T													(ng/L)	(ng/L) !
Propazine	R													50	
(ng/L)	T													(ng/L)	

TRIAZINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Sencor	R													100	
(ng/L)	T													(ng/L)	
Simazine	R													50	10000
(ng/L)	T													(ng/L)	(ng/L) !
SPECIAL PESTICIDES															
2,4-D	R													100	100000
(ng/L)	T													(ng/L)	(ng/L)
2,4-D Butyric Acid	R													200	18000
(ng/L)	T													(ng/L)	(ng/L) !
Dicamba	R													100	87000
(ng/L)	T													(ng/L)	(ng/L) !
Pentachlorophenol	R													50	10000
(ng/L)	T													(ng/L)	(ng/L) h
Picloram	R													100	
(ng/L)	T													(ng/L)	
2,4-D Propionic Acid	R													100	
(ng/L)	T													(ng/L)	
Silvex	R													50	10000
(ng/L)	T													(ng/L)	(ng/L)
2,4,5-T	R													50	
(ng/L)	T													(ng/L)	

TABLE 5.0 (cont'd.)

SPECIAL PESTICIDES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
2,3,4,5 Tetra-chlorophenol (ng/L)	R													50 (ng/L)	
	T														
2,3,5,6 Tetra-chlorophenol (ng/L)	R													50 (ng/L)	
	T														
2,3,4 Trichlorophenol (ng/L)	R													100 (ng/L)	
	T														
2,4,5 Trichlorophenol (ng/L)	R													50 (ng/l)	
	T														
2,4,6 Trichlorophenol (ng/L)	R													50 (ng/l)	10000 (ng/l) h
	T														
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/l)	R													50 (ng/l)	14000 (ng/l)
	T														
Dichlorovos (ng/l)	R														
	T														
Dursban (ng/l)	R														
	T														
Ethion (ng/L)	R														
	T														
Guthion (ng/L)	R														
	T														

TABLE 5.0 (cont'd.)

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Malathion (ng/L)	R														
	T														
Methylparathion (ng/L)	R													50 (ng/L)	7000 (ng/L)
	T														
Methyltrithion (ng/L)	R														
	T														
Mevinphos (ng/L)	R														
	T														
Parathion (ng/L)	R													50 (ng/L)	35000 (ng/L)
	T														
Phorbate (ng/L)	R														
	T														
Reldan (ng/L)	R														
	T														
Ronnel (ng/L)	R														
	T														
MASS SPEC.															
Di-N-Butyl Phthalate (ug/L)	R													0.1 (ug/L)	34000 (ug/L) e
	T														

TABLE 5.0 (cont'd.)

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
N-Dichloromethylene-Pentachloroanaline (ug/L)	R													0.1 (ug/L)	
	T														
Diphenyl Ether (ug/L)	R													0.1 (ug/L)	
	T														
Fluoranthene (ug/L)	R													0.1 (ug/L)	
	T														
Hexachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Methyl Phenanthrene (ug/L)	R													0.1 (ug/L)	
	T														
Naphthalene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropane (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Pyrene (ug/L)	R													0.1 (ug/L)	
	T														

TABLE 5.0 (cont'd.)

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Tetrachlorbutane (ug/L)	R T													0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	65	< 2	10	2100	0	103	62	0	23	212	0	22	0	
Total Coliform BKGD	R														
Fecal Coliform MF (count/100 mL)	R	9	0	2	30	0	4	29	0	4	90	0	6	0	
Standard Plate Count MF (count/mL)	R													0	500
Treated Water:														0	
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T			0			0			0			0	0 0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

TABLE 5.0 (cont'd.)

BACTERIA (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T														
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aeromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														
P/A Bottle	T														

TABLE 5.0 - FOOTNOTES

1 = see individual footnotes for agency of guideline origin
c = California State Department of Health action level
d = OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e = USEPA ambient guideline
ea = United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep = USEPA proposed maximum contaminant level for drinking water
g = suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h = World Health Organization (WHO) guideline
h* = World Health Organization (WHO) odour threshold
mg/L = milligrams per litre, parts per million (ppm)
ng/L = nanograms per litre, parts per trillion (ppt)
Presence/Absence = microbiological test to indicate presence or absence of coliform bacteria
R = raw water
T = treated drinking water
t = ODWO interim maximum acceptable concentration (IMAC)
ug/L = micrograms per litre, parts per billon (ppb)
y = New York State (taste and odour) proposed drinking water guideline
++ = total trihalomethanes
+++ = combined total: heptachlor and heptachlor epoxide
* = if other than DWSP detection limit
** = total of aldrin and dieldrin
*** = chlordane is a mixture of alpha and gamma isomers
! = Ministry of the Environment and Health and Welfare Canada (IMAC)
= No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G = ODWO suggested guideline

TABLE 5.0 - FOOTNOTES (cont'd)

(1) = No alkalinity data for December 1984.
(2) = No chloride data for December 1984.
(3) = Data for September and December 1985 only.
(4) = No fluoride data for December 1984.
(5) = No hardness data for December 1984.
(6) = No pH data for December 1984.
(7) = No fluoride added during sampling period.
(8) = These numbers obtained from Mr. G. Martin of the MOE and Mr. Eamon of the Cornwall MOE office.

TABLE 5.1: WATER QUALITY (ONE-YEAR SUMMARY)

WPOS - CORNWALL WTP

GENERAL CHEMISTRY		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
GENERAL CHEMISTRY -(A)															
Alkalinity (mg/L)	R				94.1	98.5		96.9	93.2	93.3	95.5			0.2 (mg/L)	
	T				91.2	94.4		87.9	86.8	86.5	86.2				
Ammonium (Total) (mg/L)	R													0.002 (mg/L)	
	T														
Calcium (mg/L)	R													0.1 (mg/L)	
	T														
Chloride (mg/L)	R													0.2 (mg/L)	250 (mg/L)
	T														
Colour (TCU)	R	14	15	7	7	5		5	5	6	5			0.5 (TCU)	5 (TCU)
	T	< 1	2	3	5	3		1	1	3	3				
Conductivity (umho/cm)	R	320	310	315	320	307		300	306	294	303			0.01 (umho/cm)	
	T	325	325	325	326	308		310	312	304	315				
Field Chlorine Residual (Combined)	R													0.1 (mg/L)	
	T														
Field Chlorine Residual (Free)	R													0.1 (mg/L)	
	T														
Field Chlorine Residual (Total)	R													0.1 (mg/L)	
	T														
Field pH	R													0.2	
	T														

(A) General Chemistry test results were obtained from the monthly MOE chemical testing program. Bacteriological testing is carried out once per week by the MOE.

TABLE 5.1 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Field Temperature (^{o}C)	R														
	T														
Field Turbidity (FTU)	R														1 (FTU)
	T														
Fluoride (mg/L)	R	0.22	0.18	0.15	0.16	0.31		0.22	0.18	0.14	0.13			0.01 (mg/l)	2.4 (mg/l)
	T	1.0	1.1	1.25	0.83	0.95		1.25	1.0	0.84	0.78				
Hardness (mg/L)	R													0.5 (mg/L)	
	T														
Magnesium (mg/L)	R													0.05 (mg/L)	c
	T														
Nitrate (mg/L)	R													0.05 (mg/L)	10 (mg/L as N)
	T														
Nitrite (mg/L)	R													0.005 (mg/L)	1 (mg/L as N)
	T														
Nitrogen Total Kjeldahl (mg/L)	R													0.1 (mg/L)	0.15 (mg/L) *
	T														
pH	R				8.09	7.63		8.15	8.22	8.16	8.17				8.5
	T				7.80	7.72		7.46	7.92	7.54	7.52				
Pnosphorus Filtered Reactive (mg/L)	R													0.01 (mg/L)	
	T														

TABLE 5.1 (cont'd.)

GENERAL CHEMISTRY (cont'd.)		1986 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Phosphorus (Total)	R													0.01	
(mg/L)	T													(mg/L)	
Sodium	R								11.9		12.0			0.1	
(mg/L)	T								12.8		12.8			(mg/L)	
Total Solids	R													1	
(mg/L)	T													(mg/L)	
Turbidity	R	1.3	1.7	0.53	0.52	0.63		0.75	0.90	0.73	1.6			0.01	1
(FTU)	T	0.33	0.38	0.54	0.38	0.40		2.1	0.38	2.7(1)	0.28			(FTU)	(FTU)
METALS															
Aluminum	R					(3)	(2)							0.003	0.1
(mg/L)	T	0.028(2)				0.283	0.081		0.173(2)		0.077(4)			(mg/L)	(mg/L) G
Arsenic	R													0.001	0.05
(mg/L)	T													(mg/L)	(mg/L)
Barium	R													0.001	1
(mg/L)	T													(mg/L)	(mg/L)
Beryllium	R													0.001	
(mg/L)	T													(mg/L)	
Boron														0.02	5
(mg/L)	T													(mg/L)	(mg/L)
Cadmium	R													0.0003	0.005
(mg/L)	T													(mg/L)	(mg/L)

TABLE 5.1 (cont'd.)

METALS (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Chromium	R													0.001	0.05
(mg/L)	T													(mg/L)	(mg/L)
Cobalt	R													0.001	
(mg/L)	T													(mg/L)	
Copper	R													0.001	1
(mg/L)	T													(mg/L)	(mg/L)
Cyanide	R													0.001	0.2
(mg/L)	T													(mg/L)	(mg/L)
Iron	R													0.002	0.03
(mg/L)	T													(mg/L)	(mg/L) c
Lead	R													0.003	0.05
(mg/L)	T													(mg/L)	(mg/L)
Manganese	R													0.001	0.05
(mg/L)	T						0.002							(mg/L)	(mg/L)
Molybdenum	R													0.001	
(mg/L)	T													(mg/L)	
Mercury	R													0.01	1
(ug/L)	T						0.06							(ug/L)	(ug/L)
Nickel	R													0.002	
(mg/L)	T													(mg/L)	

TABLE 5.1 (cont'd.)

METALS (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Selenium (mg/L)	R T													0.001 (mg/L)	0.01 (mg/L)
Strontium (mg/L)	R T													0.001 (mg/L)	
Tin (no units available)	R T														
Uranium (mg/L)	R T													0.002 (mg/L)	0.02 (mg/L) t
Vanadium (mg/L)	R T													0.001 (mg/L)	
Zinc (mg/L)	R T													0.001 (mg/L)	5 (mg/L) h
PURGEABLES															
Benzene (ug/L)	R T													1 (ug/L)	10 (ug/L) h
Bromoform (ug/L)	R T													1 (ug/L)	350 (ug/L) ++
Carbon Tetrachloride (ug/L)	R T													1 (ug/L)	3 (ug/L) h
Chlorobenzene (ug/L)	R T													1 (ug/L)	100-300 (ng/L) h*

TABLE 5.1 (cont'd.)

PURGEABLES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Chlorodibromomethane	R													1	350
(ug/L)	T													(ug/L)	(ug/L) ++
Chloroform	R													1	350
(ug/L)	T													(ug/L)	(ug/L) ++
1,2-Dichlorobenzene	R													1	400
(ug/L)	T													(ug/L)	(ug/L) e
1,3-Dichlorobenzene	R													1	400
(ug/L)	T													(ug/L)	(ug/L) e
1,4-Dichlorobenzene	R													1	400
(ug/L)	T													(ug/L)	(ug/L) e
Dichlorobromomethane	R													1	350
(ug/L)	T													(ug/L)	(ug/L) ++
1,1-Dichloroethane	R													1	
(ug/L)	T													(ug/L)	
1,2-Dichloroethane	R													1	10
(ug/L)	T													(ug/L)	(ug/L) h
1,1-Dichloroethylene	R													1	0.3
(ug/L)	T													(ug/L)	(ug/L) h
1,1,2-Dichloroethylene	R													1	
(ug/L)	T													(ug/L)	

PURGEABLES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]	
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
Dichloromethane (ug/L)	R T													5 (ug/L)	40 (ug/L)	c
1,2-Dichloropropane (ug/L)	R T													1 6 (ug/L)		
Ethylbenzene (ug/L)	R T													1 (ug/L)	1400 (ug/L)	e
Ethylene Dibromide (ug/L)	R T															
M-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L)	c
O-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L)	c
P-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L)	c
Toluene (ug/L)	R T													1 (ug/L)	100 (ug/L)	c
1,1,2,2-Tetra-chloroethane (ug/L)	R T													1 (ug/L)	1.7 (ug/L)	e
Tetrachloroethane (ug/L)	R T													1 (ug/L)	10 (ug/L)	h

TABLE 5.1 (cont'd.)

PURGEABLES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1,1,1-Trichloroethane (ug/L)	R T													1 (ug/L)	1000 (ug/l) c
1,1,2 Trichloroethane (ug/l)	R T													1 (ug/L)	6 (ug/l) e
Trichloroethylene (ug/L)	R T													1 (ug/L)	30 (ug/L) h
Total Trihalomethanes (ug/l)	R T													3 (ug/l)	350 (ug/l) ++
Trifluorochlorotoluene (ug/L)	R T													1 (ug/l)	
ORGANOCHLORINES															
Aldrin (ng/L)	R T													1 (ng/L)	700 (ng/L) **
Alpha BHC (ng/l)	R T													1 (ng/L)	700 (ng/L) c
Alpha Chlordane (ng/l)	R T													2 (ng/L)	700 (ng/l) ***
Beta BHC (ng/l)	R T													1 (ng/l)	300 (ng/l) c
Dieldrin (ng/L)	R T													2 (ng/l)	700 (ng/l) **

TABLE 5.1 (cont'd.)

ORGANOCHLORINES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Endrin	R													4	200
(ng/L)	T													(ng/L)	(ng/L)
Gamma Chlordane	R													2	700
(ng/L)	T													(ng/L)	(ng/L) ***
Heptachlor Epoxide	R													1	3000
(ng/L)	T													(ng/L)	(ng/L) +++
Heptachlor	R													1	3000
(ng/L)	T													(ng/L)	(ng/L) +++
Hexachlorobenzene	R													1	10
(ng/L)	T													(ng/L)	(ng/L) h
Hexachlorobutadiene	R														
(ug/L)	T														
Hexachloroethane	R													1	19000
(ng/L)	T													(ng/L)	(ng/L) e
Lindane	R													1	4000
(ng/L)	T													(ng/L)	(ng/L)
Methoxychlor	R													5	100000
(ng/L)	T													(ng/L)	(ng/L)
Mirex	R													5	
(ng/L)	T													(ng/L)	

TABLE 5.1 (cont'd.)

ORGANOCHLORINES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Octachlorostyrene	R													1	
(ng/L)	T													(ng/L)	
O,P DDT	R													5	30000
(ng/L)	T													(ng/L)	(ng/L) d
Oxychlordane	R													2	
(ng/L)	T													(ng/L)	
PCB Total	R													20	3000
(ng/L)	T													(ng/L)	(ng/L) t
Pentachlorobenzene	R													1	74000
(ng/L)	T													(ng/L)	(ng/L) e
P,P-DDD	R													5	
(ng/l)	T													(ng/L)	d
P,P-DDE	R													1	
(ng/l)	T													(ng/L)	d
P,P DDT	R													5	
(ng/L)	T													(ng/L)	d
1,2,3,4-Tetra-	R													1	
chlorobenzene (ng/L)	T													(ng/L)	
1,2,3,5-Tetra-	R													1	
chlorobenzene (ng/L)	T													(ng/L)	

TABLE 5.1 (cont'd.)

ORGANOCHLORINES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1,2,4,5-Tetrachlorobenzene (ng/L)	R T													1 (ng/L)	38000 (ng/L) e
Thiodan I (ng/L)	R T													2 (ng/L)	74000 (ng/L) ea
Thiodan II (ng/L)	R T													4 (ng/L)	74000 (ng/L) ea
Thiodan Sulphate (ng/L)	R T													4 (ng/L)	
Toxaphene (no units available)	R T														
1,2,3-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
1,2,4-Trichlorobenzene (ng/L)	R T													5 (ng/L)	15000 (ng/L) y
1,3,5-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
2,3,6-Trichlorotoluene (ng/L)	R T													5 (ng/L)	
2,4,5-Trichlorotoluene (ng/L)	R T													5 (ng/L)	10000 (ng/L) g

TABLE 5.1 (cont'd.)

TRIAZINES		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
TRIAZINES															
2,6,A Trichlorotoluene	R													5	
(ng/l)	T													(ng/L)	
Alachlor	R														
(ng/l)	T														
Ametrine	R													50	
(ng/L)	T													(ng/L)	
Atratone	R														
(ng/L)	T														
Atrazine	R													50	46000
(ng/L)	T													(ng/L)	(ng/L) !
Bladex	R													100	10000
(ng/l)	T													(ng/L)	(ng/L) !
Metolachlor	R														
(ng/l)	T														
Prometone	R													50	
(ng/L)	T													(ng/L)	
Prometryne	R													50	1000
(ng/L)	T													(ng/L)	(ng/L) !
Propazine	R													50	
(ng/L)	T													(ng/L)	

TABLE 5.1 (cont'd.)

TRIAZINES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Sencor (ng/L)	R													100 (ng/L)	
	T														
Simazine (ng/L)	R													50 (ng/L)	10000 (ng/L) !
	T														
SPECIAL PESTICIDES															
2,4-D (ng/L)	R													100 (ng/L)	100000 (ng/L)
	T														
2,4-D Butyric Acid (ng/L)	R													200 (ng/L)	18000 (ng/L) !
	T														
Dicamba (ng/L)	R													100 (ng/L)	87000 (ng/L) !
	T														
Pentachlorophenol (ng/L)	R													50 (ng/L)	10000 (ng/L) h
	T														
Picloram (ng/L)	R													100 (ng/L)	
	T														
2,4-D Propionic Acid (ng/L)	R													100 (ng/L)	
	T														
Silvex (ng/L)	R													50 (ng/L)	10000 (ng/L)
	T														
2,4,5-T (ng/L)	R													50 (ng/L)	
	T														

SPECIAL PESTICIDES (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
2,3,4,5-Tetrachlorophenol (ng/L)	R													50 (ng/L)	
	T														
2,3,5,6-Tetrachlorophenol (ng/L)	R													50 (ng/L)	
	T														
2,3,4-Trichlorophenol (ng/L)	R													100 (ng/L)	
	T														
2,4,5-Trichlorophenol (ng/L)	R													50 (ng/L)	
	T														
2,4,6-Trichlorophenol (ng/L)	R													50 (ng/L)	10000 (ng/L) h
	T														
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/L)	R													50 (ng/L)	14000 (ng/L)
	T														
Dichlorovos (ng/L)	R													10 (ng/L)	
	T														
Dursban (ng/L)	R													10 (ng/L)	
	T														
Ethion (ng/L)	R													10 (ng/L)	
	T														
Guthion (ng/L)	R													1000 (ng/L)	
	T														

TABLE 5.1 (cont'd.)

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Malathion (ng/L)	R													10.0 (ng/L)	
	T														
Methylparathion (ng/L)	R													50 (ng/L)	7000 (ng/L)
	T														
Methyltrithion (ng/L)	R													100 (ng/L)	
	T														
Mevinphos (ng/L)	R													10 (ng/L)	
	T														
Parathion (ng/L)	R													50 (ng/L)	35000 (ng/L)
	T														
Phorbate (ng/L)	R													10 (ng/L)	
	T														
Reldan (ng/L)	R													10 (ng/L)	
	T														
Ronnel (ng/L)	R													10 (mg/L)	
	T														
MASS SPEC.															
Di-n-Butyl Phthalate (ug/L)	R													0.1 (ug/L)	34000 (ug/L) e
	T														

TABLE 5.1 (cont'd.)

MASS SPEC. (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
N-Dichloromethylene-Pentachloroanaline (ug/L)	R													0.1 (ug/L)	
	T														
Diphenyl Ether (ug/L)	R													0.1 (ug/L)	
	T														
Fluoranthene (ug/L)	R													0.1 (ug/L)	
	T														
Hexachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Methyl Phenanthrene (ug/L)	R													0.1 (ug/L)	
	T														
Naphthalene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropane (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Pyrene (ug/L)	R													0.1 (ug/L)	
	T														

TABLE 5.1 (cont'd.)

MASS SPEC. (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Tetrachlorbutane (ug/l)	R T													0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	5	27	22	3	14	77	32	4	14	40	2			
Total Coliform BKGD	R														
Fecal Coliform MF (count/100 mL)	R	1	0	1	0	4	30	7	1	2	16	1		0	
Standard Plate Count MF (count/mL)	R													0	500
Treated Water:															
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T	0	0	0	0	0	0	0	0	0	0	0		0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

TABLE 5.1 (cont'd.)

BACTERIA (cont'd.)		1986												DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T														
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														
P/A Bottle	T														

TABLE 5.1 - FOOTNOTES

I = see individual footnotes for agency of guideline origin
c = California State Department of Health action level
d = OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e = USEPA ambient guideline
ea - United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep = USEPA proposed maximum contaminant level for drinking water
g = suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h = World Health Organization (WHO) guideline
h* = World Health Organization (WHO) odour threshold
mg/L = milligrams per litre, parts per million (ppm)
ng/L = nanograms per litre, parts per trillion (ppt)
Presence/Absence = microbiological test to indicate presence or absence of coliform bacteria
R = raw water
T = treated drinking water
t = ODWO interim maximum acceptable concentration (IMAC)
ug/L = micrograms per litre, parts per billon (ppb)
y = New York State (taste and odour) proposed drinking water guideline
++ = total trihalomethanes
+++ = combined total: heptachlor and heptachlor epoxide
* = if other than DWSP detection limit
** = total of aldrin and dieldrin
*** = chlordane is a mixture of alpha and gamma isomers
! = Ministry of the Environment and Health and Welfare Canada (IMAC)
- No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G = ODWO suggested guideline

TABLE 5.1 - FOOTNOTES (cont'd)

(1) = Note on MOE lab report indicates that sample contained large particles similar to kettle scale.
(2) = Average of 4 tests, each one for filter effluents 1 - 4.
(3) = Average of 3 tests, each one for filter effluents 2 - 4.
(4) = Average of 2 tests, each one for filter effluents 1,3.

TABLE 7.0: BACTERIOLOGICAL TESTING

WPOS - CORNWALL WTP

		1986						1985					
		FECAL COLI			TOTAL COLI			FECAL COLI			TOTAL COLI		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	2	0	1	12	1	5	9	0	5	88	1	40
	T						0						0
FEB	R	1	0	0	52	1	27	3	1	2	24	2	11
	T						0						0
MAR	R	3	0	1	46	3	22	1	0	1	32	2	15
	T						0						0
APR	R	0	0	0	6	1	3	3	0	1	8	0	2
	T						0						0
MAY	R	16	0	4	30	1	14	23	1	8	62	4	27
	T				1	0	0						0
JUN	R	90	5	30	212	18	77	29	4	15	58	1	22
	T						0				1	0	0
JUL	R	19	1	7	60	12	32	5	0	2	26	1	8
	T						0						0
AUG	R	2	0	1	8	1	4	6	0	3	12	1	6
	T				2	0	0						0
SEP	R	5	0	2	58	1	14	1	0	0	6	0	3
	T						0						0
OCT	R	32	1	16	62	2	40	7	0	4	100	1	55
	T						0						0
NOV	R						2	13	3	7	100	10	47
	T						0						0
DEC	R							1	0	0	100	2	35
	T												0

- All results are for 100 mL samples; test carried out weekly at MOE lab, Resources Road, Toronto.
- Blanks indicate no testing carried out.
- Averages are rounded to the nearest whole number.

TABLE 7.1: BACTERIOLOGICAL TESTING

Page 1 of 1

WPOS - CORNWALL WTP

		1984						1983					
		FECAL COLI			TOTAL COLI			FECAL COLI			TOTAL COLI		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	10	1	4	18	4	11	1	0	1	32	2	11
	T						0						0
FEB	R	1	0	0	20	1	6	0	0	0	2	2	2
	T						0						0
MAR	R	1	0	0	4	1	3	0	0	0	2	2	2
	T						0						0
APR	R	0	0	0	2	1	1	1	0	1	6	2	3
	T						0						0
MAY	R	10	0	6	20	1	11	9	0	3	65	2	19
	T						0						0
JUN	R	30	0	11	36	1	17	6	0	2	42	2	19
	T						0						0
JUL	R	15	3	7	91	4	25	0	0	0	36	2	3
	T						0						0
AUG	R	3	0	1	2100	8	1054	2	0	1	100	2	27
	T				1	0	0						0
SEP	R	1	0	0	6	1	2	2	1	1	4	2	3
	T				1	0	0						0
OCT	R	9	3	6	38	3	18						
	T						0						
NOV	R	4	2	3	18	0	7	9	5	8	18	14	17
	T						0						0
DEC	R	14	0	6	220	1	80	4	1	2	4	2	3
	T						0						0

- All results are for 100 mL samples; tests carried out weekly at MOE lab, Resources Road, Toronto.
- Blanks indicate no testing carried out.
- Averages are rounded to the nearest whole number.

TABLE 7.2: BACTERIOLOGICAL TESTING (1983)

CORNWALL WTP - WPOS

		TOTAL COLIFORM			TOTAL COLIFORM			FECAL COLIFORM		
		Max	Min	Avg	0	1-4	5+	0	1-4	5+
JAN	R	32	<2	11		2	2	2	2	
	T				44					
FEB	R	2	<2	2		4		4		
	T				36					
MAR	R	2	<2	2		4		4		
	T				36					
APR	R	6	<2	3		3	1	3	1	
	T				23	1				
MAY	R	65	<2	19		2	3	3	1	1
	T				54	1				
JUN	R	42	<2	19		1	3	2	1	1
	T				41	2				
JUL	R	36	<2	8		5	1			
	T				24					
AUG	R	<100	<2	27		3	1	3	3	
	T				47					
SEP	R	4	0	2	1	2			3	
	T				28					
OCT	R	(NO RESULTS)			(NO RESULTS)			(NO RESULTS)		
	T				36					
NOV	R	18	14	17			4			4
	T				30					
DEC	R	4	0	2	1	2			3	
	T				32					

NOTE: Tests conducted at the MOE Regional Office laboratory, Kingston, Ontario.
All results are for 100 mL samples.
Raw water total coliform monthly max, min and avg values provided from weekly sampling.
Treated water samples consist of the plant effluent and seven distribution system samples. The test results were sorted into the above total count ranges.

TABLE 7.3: BACTERIOLOGICAL TESTING (1984)

Page 1 of 1

CORNWALL WTP - WPOS

		TOTAL COLIFORM			TOTAL COLIFORM			FECAL COLIFORM		
		Max	Min	Avg	0	1-4	5+	0	1 4	5+
JAN	R	18	4	11		1	3		3	1
	T				43					
FEB	R	20	<2	7		3	1	3	1	
	T				43					
MAR	R	4	<2	3		4		2	1	
	T				35	1				
APR	R	2	<2	2		2		2		
	T				33					
MAY	R	20	<2	11		1	4	1		4
	T				48	1				
JUN	R	36	<2	18		1	3	1		3
	T				35					
JUL	R	91	1	25		2	3		2	1
	T				44	2				
AUG	R	<100	0	27	2		2	2	2	
	T				30	5				
SEP	R	6	<2	3		3	1	3	1	
	T				32	3				
OCT	R	38	3	18		2	3		2	3
	T				46					
NOV	R	18	12	15			2		2	
	T				36					
DEC	R	220	<2	81		1	2	1	1	1
	T				16	1				

NOTE: Tests conducted at the MOE Regional Office laboratory, Kingston, Ontario.
All results are for 100 mL samples.
Raw water total coliform monthly max, min and avg values provided from weekly sampling.
Treated water samples consist of the plant effluent and seven distribution system samples. The test results were sorted into the above total count ranges.

TABLE 7.4: BACTERIOLOGICAL TESTING (1985)

CORNWALL WTP - WPOS

		TOTAL COLIFORM			TOTAL COLIFORM			FECAL COLIFORM		
		Max	Min	Avg	0	1-4	5+	0	1-4	5+
JAN	R	88	<2	40		1	3	1		2
	T				44					
FEB	R	24	2	11		1	2		2	1
	T				24					
MAR	R	32	2	15		1	2	1	2	
	T				44					
APR	R	8	<2	4		3	1	3	1	
	T				38					
MAY	R	62	4	28		1	3		2	2
	T				36					
JUN	R	58	<2	22		1	3		1	2
	T				41	2				
JUL	R	26	<2	10		2	3	2	2	1
	T				39					
AUG	R	12	<2	7		2	2	1	1	2
	T				36					
SEP	R	6	<2	4		2	1	2	1	
	T				33					
OCT	R	<100	<2	34		2	3	1	2	2
	T				47					
NOV	R	<100	10	47			3		2	1
	T				33					
DEC	R	<100	2	35		2	1	2	1	
	T				33					

NOTE: Tests conducted at the MOE Regional Office laboratory, Kingston, Ontario.
All results are for 100 mL samples.
Raw water total coliform monthly max, min and avg values provided from weekly sampling.
Treated water samples consist of the plant effluent and seven distribution system samples. The test results were sorted into the above total count ranges.

TABLE 7.5: BACTERIOLOGICAL TESTING (1986)

CORNWALL WTP - WPOS

		TOTAL COLIFORM			TOTAL COLIFORM			FECAL COLIFORM		
		Max	Min	Avg	0	1-4	5+	0	1-4	5+
JAN	R	12	<2	5		2	1	2	1	
	T				33					
FEB	R	52	<2	27		1	3	2	2	
	T				43					
MAR	R	46	3	22		1	2	1	2	
	T				29					
APR	R	6	<2	4		3	1	4		
	T				44					
MAY	R	30	<2	17		2	1	2		1
	T				31	3				
JUN	R	212	4	56		1	5	1	1	4
	T				50					
JUL	R	60	12	32			4		3	1
	T				35	2	1			
AUG	R	8	<2	5		2	1	1	2	
	T				33					
SEP	R	58	<2	14		3	2	2	2	1
	T				47					
OCT	R	62	2	40		1	2		1	2
	T				32					
NOV	R	5	2	3		2	1	1	1	1
	T				33					
DEC	R	54	6	23			3	1	1	1
	T				31					

NOTE: Tests conducted at the MOE Regional Office laboratory, Kingston, Ontario.
All results are for 100 mL samples.
Raw water total coliform monthly max, min and avg values provided from weekly sampling.
Treated water samples consist of the plant effluent and seven distribution system samples. The test results were sorted into the above total count ranges.

TABLE 8.0: ALERT LEVELS
(TREATED WATER AT PLANT)

WPOS - CORNWALL WTP

DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT
Jan/83	Turbidity	1.8 FTU	1.0 FTU
Sep/83	Iron	0.7 mg/L	0.3 mg/L
Dec/84	Iron	1.3 mg/L	0.3 mg/L
Jul/86	Turbidity	2.1 FTU	1.0 FTU
Sep/86	Turbidity	2.7 FTU	1.0 FTU
Aug/84	Total Coliform	1	0
Sep/84	Total Coliform	1	0
Jun/85	Total Coliform	1	0
May/86	Total Coliform	1	0
Aug/86	Total Coliform	1	0

During the summer and autumn months of each year (June-October), the temperature exceeded the guideline limit of 15°C.

APPENDIX B

FILTER BACKWASHING GUIDELINES AND PROCEDURE

Cornwall Water Purification Plant Operational Duties

OPERATIONAL DUTIES

All filters have to be backwashed in order to maintain the beds in good condition.

The filters at the Cornwall Water Purification Plant are equipped with surface wash facilities, of the rotating jet type, which assist in cleaning the beds by their scouring action.

The following procedure is to be followed for backwashing filters and keeping filter log records until further notice.

FILTERS TO BE BACKWASHED

1. When loss of head reached approximately six feet.
2. When filter has had forty-eight hours service, regardless of loss of head.

WASHING FILTER

1. Close influent valve.
2. Close effluent valve.
3. Open drain valve. Allow water to filter down to level of weir plates.
4. Open surface wash valve, "AGITATOR".
5. Open wash water valve.
6. Put wash control on low rate for at least two minutes.
7. Start backwash pump.
8. Shut surface wash valve.
9. Bring filter backwash up to high rate and hold filter at high backwash rate until filter becomes reasonably clear.
10. Close wash water rate setter and when control meter shows zero or no water over weir plates, stop pump.
11. Close wash valve.

PUTTING FILTER IN SERVICE

1. Close drain valve.
2. Open influent valve.
3. When operating level is reached, open effluent valve. Check to see that the rate of flow controller opens up in the pipe gallery, immediately below you on the next floor level.

   Filters which have become air bound because of excessive loss of head or in which the water level has been allowed to go below the sand surface must be very carefully backwashed, the air should be released very slowly in order to avoid sand eruptions. Call Superintendent if this happens. The backwash at the beginning of the wash should be at low rate (3,000,000) g.p.d.

EMERGENCY HOME PHONE NO'S.

T. Gemmell	938-2151
C. Hedley	931-1700
S. Seguin	938-6119

PLANT OPERATION

1. Hourly record gauge readings on log sheet.
2. Make routine check of pumps, chemical feeders and filter beds.

SCHEDULED OPERATIONS

1. Telephone answering service as per schedule.
2. Weather Report - Log Sheet - 11:00 a.m. and 5:00 p.m.

   Climatological Sheet - 6:00 a.m. and 6:00 p.m.

   (RESET THERMOMETERS)

FOR EACH TWELVE HOUR PERIOD

1. Hourly chlorine residual tests on each filter bed and plant output.
2. Mark on log sheet results.
3. Maintain water pressure.

CALL-IN SERVICE TAS - 933-5454

When a shift operator is on duty alone on weekends, statutory holidays or night shift, he will push the security alarm every two hours starting at 2000 hrs. and every two hours thereafter.

BOUNDARY ROAD RESERVOIR

The lights on the reservoir panel indicates whether the altitude valve is closed or opened. They have no direct connection with automatic or manual setting. When the switch is on manual position the valve MUST close, when on the automatic position it can either be closed or opened. The automatic position will allow the altitude valve to open if the reservoir is below the full mark and no pumps are running -

Boundary Road Reservoir cont'd.

IT WILL NOT OPEN -

1. when pumps are running,
2. when pressure at the reservoir is below 60 psi,
3. when the water level is above 17.5 feet,
4. when the switch at the plant is on manual position.

The altitude valve should be left on the manual position during the hours 6:00 am to 8:00 pm so water will not be let off during peak demand periods. It may be put on the automatic position 8:00 pm to 6:00 pm so it will fill, if the water level is down, during off peak hours.

APPENDIX C

JAR TESTING

CORNWALL WTP

Jar Test Procedure

The MSTS test procedure which was used for all testing carried out on Cornwall raw water was as follows:

1. 200 ml sample.
2. Two minutes fast mix.
3. Thirty minutes flocculation mixing.
4. Thirty minutes settling time.
5. Filtration through pre-filter, followed by 1.2 µm filter.

The MSTS test procedure is a technique developed by Gore & Storrie Limited which has been shown to provide overall results similar to full scale conventional plant operations consisting of coagulation, flocculation, sedimentation and dual media filtration.

LABORATORY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Nov/86	MOE Water Plant Optimization Study - Cornwall WTP	380.63

SAMPLE NO. & DESCRIPTION

1 - Cornwall raw water

PARAMETERS	SAMPLE NO. 1	SAMPLE NO.	SAMPLE NO.	SAMPLE NO.
pH	7.80			
Colour (TCU)	<5			
Turbidity (NTU)	1.2			
Alkalinity (mg/L as $CaCO_3$)	104			
Hardness (mg/L as $CaCO_3$)	126			
Iron (mg/L)				
Manganese (mg/L)				

COMMENTS

CONDUCTED BY	REVIEWED BY

Gore & Storrie Limited

TEST NO. 1

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
25 Nov/86	MOE Water Plant Optimization Study - Cornwall WTP	380.63

TEST DESCRIPTION

Removal of Turbidity with Alum

JAR NO.	CHEMICAL DOSAGES (mg/L)			WATER QUALITY AFTER TREATMENT					
	Alum	Floc Rating		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	5	4		7.6	0.25	<5	76	142	
2	10	3		7.6	0.15	<5	82	134	
3	15	3		7.4	0.09	<5	80	134	
4	20	3		7.4	0.07	<5	80	132	
5	25	3		7.3	0.07	<5	74	130	
6	30	3		7.3	0.06	<5	69	130	
7									
RAW,UNTREATED				7.5	1.20	<5	82	132	

SAMPLE TEMPERATURE Start: 9°C Finish: 23°C

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

TEST NO. 2

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
1 Dec/86	MOE Water Plant Optimization Study - Cornwall WTP	380.63

TEST DESCRIPTION

Removal of Turbidity with Alum

JAR NO.	CHEMICAL DOSAGES (mg/L)			WATER QUALITY AFTER TREATMENT					
	Alum	Floc Rating		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	2.5	3-4		7.7	0.23	<5	90	127	
2	10.0	2-3		7.6	0.18	<5	84	128	
3									
4									
5									
6									
7									
RAW,UNTREATED				7.5	1.20	<5	82	132	

SAMPLE TEMPERATURE Start: 9°C Finish: 19°C

COMMENTS

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

APPENDIX D

DAILY LOG

CITY OF CORNWALL WATER PURIFICATION PLANT

DATE: ____________________

	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
PRE CL_2 FREE RESID																								
RATE																								
POST CL_2 FREE RESID																								
RATE																								
PLANT RESERVOIR																								
PLANT PRESSURE																								
Nº 1 RESERVOIR LEVEL																								
Nº 1 RESERVOIR PRESSURE																								

FILTER BACKWASH	TIME IN MINUTES	PUMP		WASH WATER VOLUME	FILTER RUN
		ON	OFF	TOTAL m³	HOURS

TURBIDITY

RAW ____________

TREATED ____________

REMARKS:

EQUIPMENT IN USE									
MACHINE	ON	OFF	ON	OFF	ON	OFF	YEST.	TODAY	DIFF.
ELECTRIC PUMP Nº 1									
ELECTRIC PUMP Nº 2									
ELECTRIC PUMP Nº 3									
DIESEL PUMP Nº 4									
ELECTRIC PUMP Nº 5									
DIESEL PUMP Nº 5									
GENERATOR SET									
BOUNDARY RD. Nº 1									
BOUNDARY RD. Nº 2									
BOUNDARY RD. Nº 3									
BOUNDARY RD., GENERATOR SET									
BACKWASH PUMP (MIN.)									
CL_2 PRE									
CL_2 SPARE									
CL_2 POST									
FLUORIDE PUMP NO. 1									
FLUORIDE PUMP Nº 2									
LIQUID ALUM PUMP Nº 1									
LIQUID ALUM PUMP Nº 2									

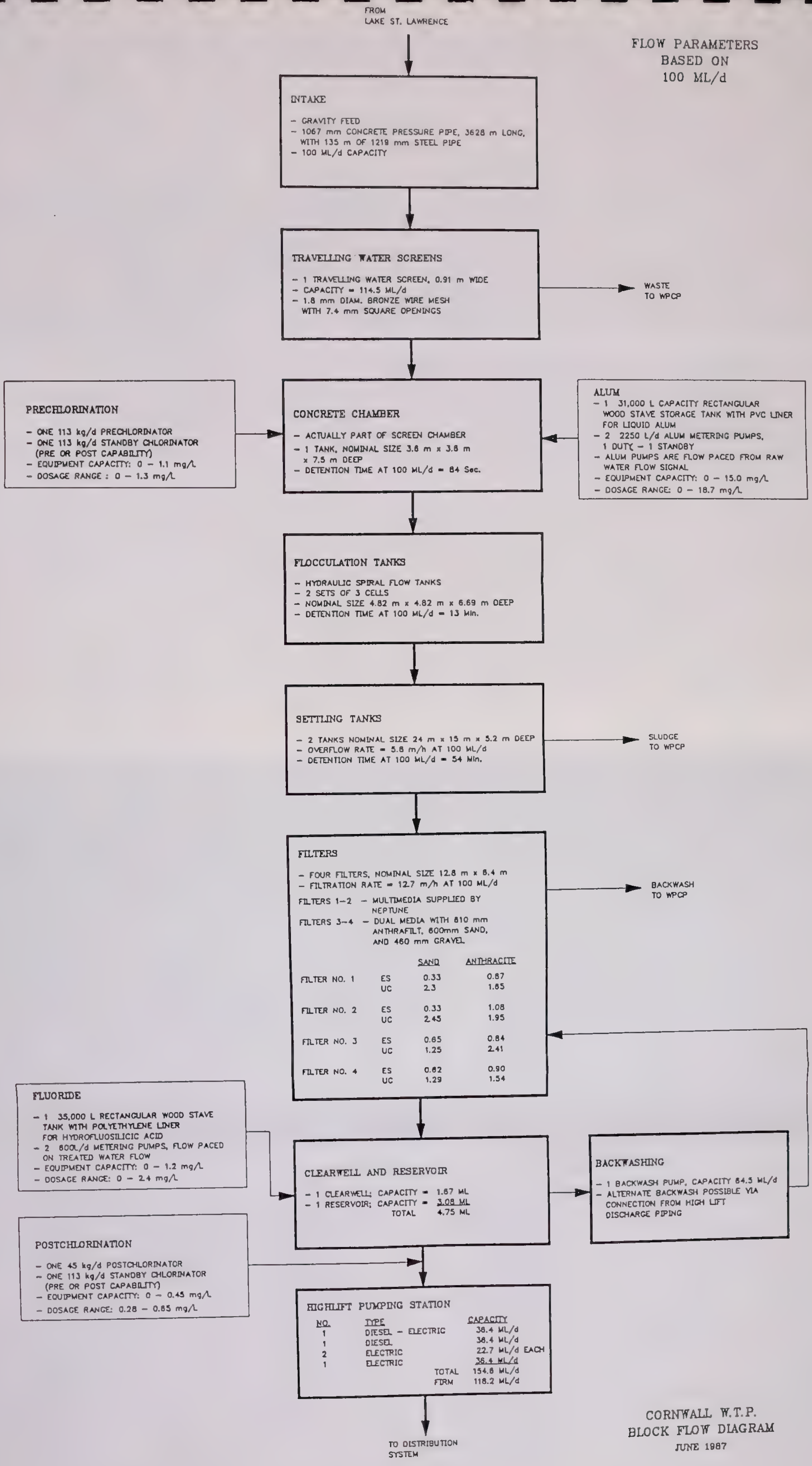
METER	YESTERDAY	TODAY	DIFF.	WEATHER
ALUM (gals)				
ALUM (inches)				
FLUORINE (inches)				
CHLORINE SCALE (Kg)				
PURE WATER (m³) M.I.G.D				TIME ________ am pm
RAW WATER (m³)				HIGH TODAY
WASH WATER (m³)				LOW TODAY
FILTER FLOW (Gal. x 10³)				PRESENT
BOUNDARY RD. RESER. (Gal.)				BAROMETER
ELEC. PEAK (Kw)				HUMIDITY
ELEC. PEAK (Kva)				WIND DIRECTION
ELEC. Kw. HOURS				WIND VELOCITY
				PRECIPITATION

SHIFT	OPERATOR	SCREEN HOUSE	FLUORIDE RESIDUAL	WATER TEMPERATURE	PRECIPITATION	
0100 - 0700 HRS.					START:	START:
0700 - 1300 HRS.					STOP:	STOP:
1300 - 1900 HRS.					START:	START:
1900 - 0100 HRS.					STOP:	STOP:

APPENDIX E

DRAWINGS

FLOW PARAMETERS
BASED ON
100 ML/d



INTAKE

- GRAVITY FEED
- 1067 mm CONCRETE PRESSURE PIPE, 3628 m LONG, WITH 135 m OF 1219 mm STEEL PIPE
- 100 ML/d CAPACITY

TRAVELLING WATER SCREENS

- 1 TRAVELLING WATER SCREEN, 0.91 m WIDE
- CAPACITY = 114.5 ML/d
- 1.8 mm DIAM. BRONZE WIRE MESH WITH 7.4 mm SQUARE OPENINGS

PRECHLORINATION

- ONE 113 kg/d PRECHLORINATOR
- ONE 113 kg/d STANDBY CHLORINATOR (PRE OR POST CAPABILITY)
- EQUIPMENT CAPACITY: 0 – 1.1 mg/L
- DOSAGE RANGE : 0 – 1.3 mg/L

CONCRETE CHAMBER

- ACTUALLY PART OF SCREEN CHAMBER
- 1 TANK, NOMINAL SIZE 3.8 m x 3.8 m x 7.5 m DEEP
- DETENTION TIME AT 100 ML/d = 84 Sec.

ALUM

- 1 31,000 L CAPACITY RECTANGULAR WOOD STAVE STORAGE TANK WITH PVC LINER FOR LIQUID ALUM
- 2 2250 L/d ALUM METERING PUMPS, 1 DUTY – 1 STANDBY
- ALUM PUMPS ARE FLOW PACED FROM RAW WATER FLOW SIGNAL
- EQUIPMENT CAPACITY: 0 – 15.0 mg/L
- DOSAGE RANGE: 0 – 18.7 mg/L

FLOCCULATION TANKS

- HYDRAULIC SPIRAL FLOW TANKS
- 2 SETS OF 3 CELLS
- NOMINAL SIZE 4.82 m x 4.82 m x 6.69 m DEEP
- DETENTION TIME AT 100 ML/d = 13 Min.

SETTLING TANKS

- 2 TANKS NOMINAL SIZE 24 m x 15 m x 5.2 m DEEP
- OVERFLOW RATE = 5.8 m/h AT 100 ML/d
- DETENTION TIME AT 100 ML/d = 54 Min.

FILTERS

- FOUR FILTERS, NOMINAL SIZE 12.8 m x 8.4 m
- FILTRATION RATE = 12.7 m/h AT 100 ML/d

FILTERS 1–2 – MULTIMEDIA SUPPLIED BY NEPTUNE

FILTERS 3–4 – DUAL MEDIA WITH 810 mm ANTHRAFILT, 600mm SAND, AND 460 mm GRAVEL

		SAND	ANTHRACITE
FILTER NO. 1	ES	0.33	0.87
	UC	2.3	1.65
FILTER NO. 2	ES	0.33	1.08
	UC	2.45	1.95
FILTER NO. 3	ES	0.65	0.84
	UC	1.25	2.41
FILTER NO. 4	ES	0.82	0.90
	UC	1.29	1.54

FLUORIDE

- 1 35,000 L RECTANGULAR WOOD STAVE TANK WITH POLYETHYLENE LINER FOR HYDROFLUOSILICIC ACID
- 2 600L/d METERING PUMPS, FLOW PACED ON TREATED WATER FLOW
- EQUIPMENT CAPACITY: 0 – 1.2 mg/L
- DOSAGE RANGE: 0 – 2.4 mg/L

CLEARWELL AND RESERVOIR

- 1 CLEARWELL; CAPACITY = 1.67 ML
- 1 RESERVOIR; CAPACITY = 3.08 ML

TOTAL 4.75 ML

BACKWASHING

- 1 BACKWASH PUMP, CAPACITY 84.5 ML/d
- ALTERNATE BACKWASH POSSIBLE VIA CONNECTION FROM HIGH LIFT DISCHARGE PIPING

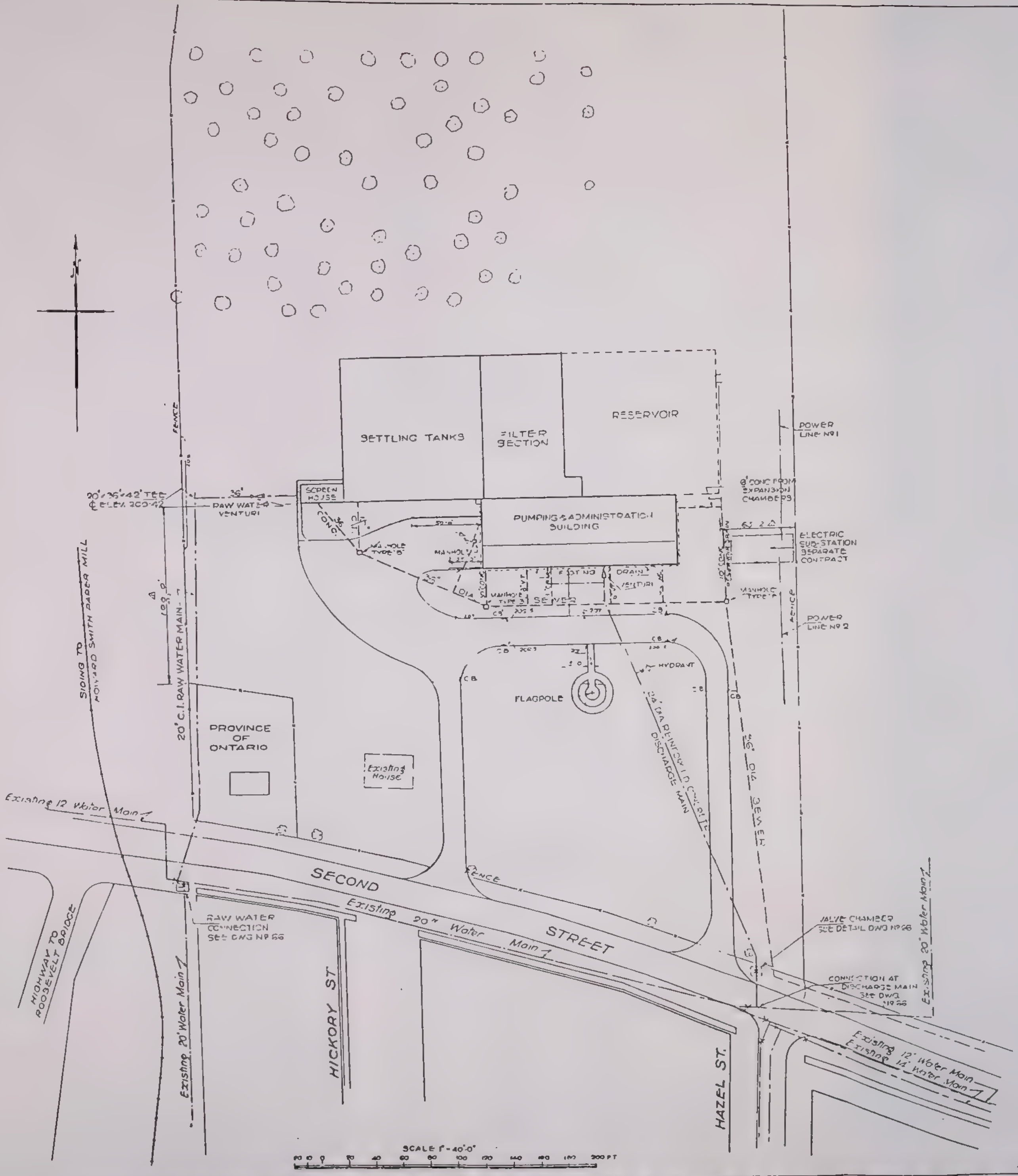
POSTCHLORINATION

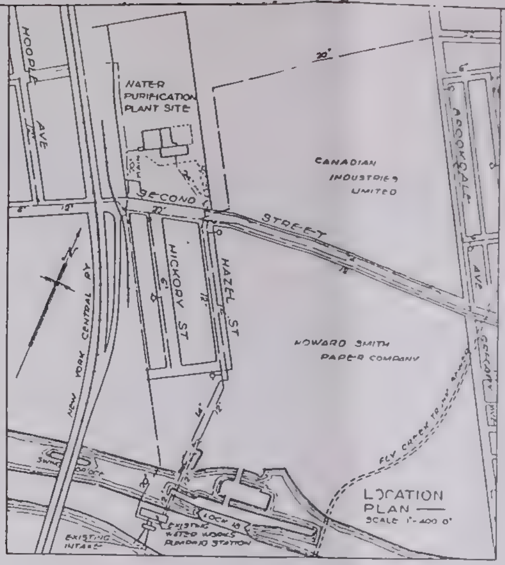
- ONE 45 kg/d POSTCHLORINATOR
- ONE 113 kg/d STANDBY CHLORINATOR (PRE OR POST CAPABILITY)
- EQUIPMENT CAPACITY: 0 – 0.45 mg/L
- DOSAGE RANGE: 0.28 – 0.85 mg/L

HIGHLIFT PUMPING STATION

NO.	TYPE		CAPACITY
1	DIESEL – ELECTRIC		38.4 ML/d
1	DIESEL		38.4 ML/d
2	ELECTRIC		22.7 ML/d EACH
1	ELECTRIC		36.4 ML/d
		TOTAL	154.6 ML/d
		FIRM	118.2 ML/d

CORNWALL W.T.P.
BLOCK FLOW DIAGRAM
JUNE 1987





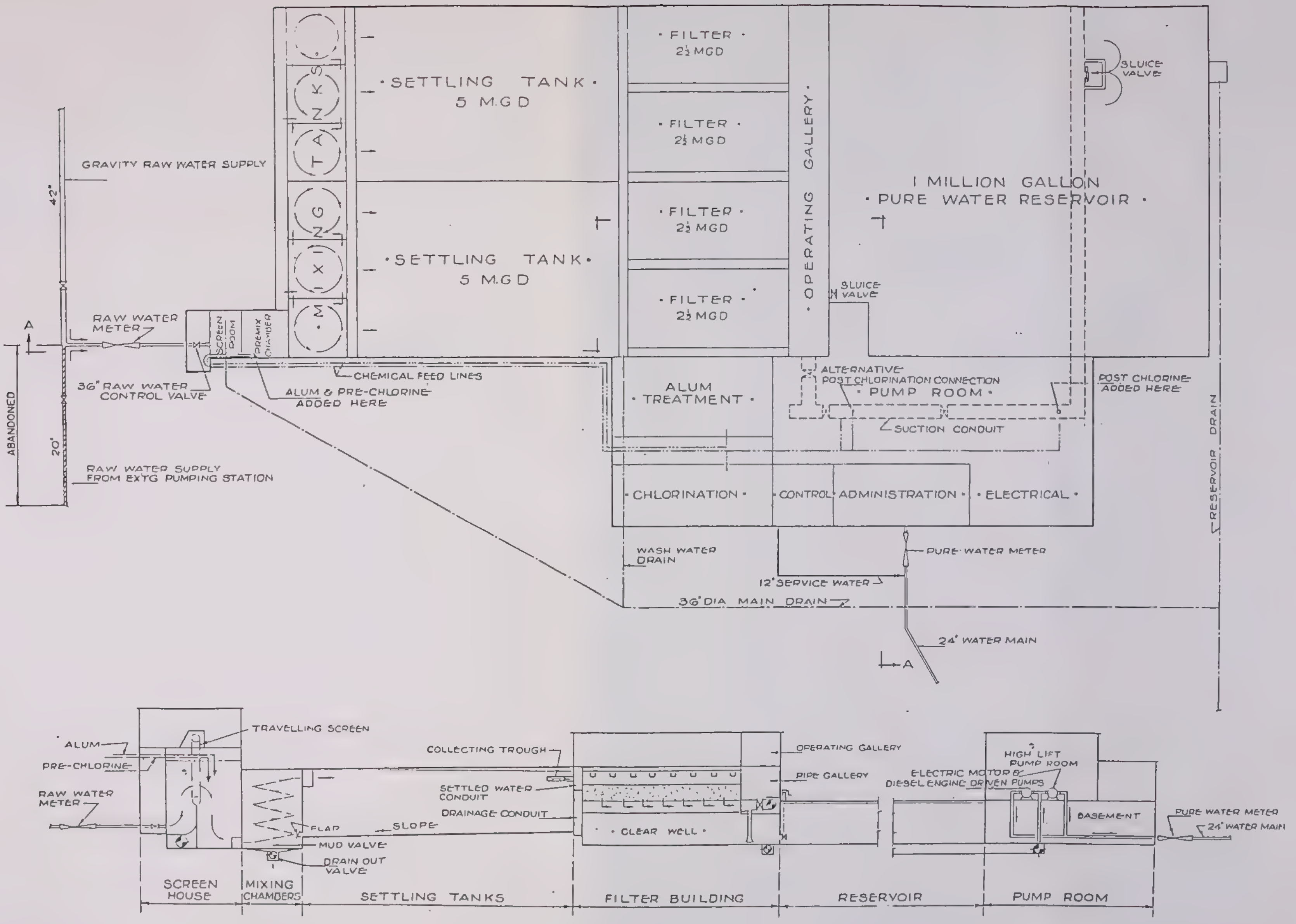
LOCATION PLAN
SCALE 1" = 400' 0"

CITY OF CORNWALL

WATER PURIFICATION PLANT

SITE PLAN

GORE & STORRIE LIMITED
CONSULTING ENGINEERS
TORONTO



— SECTION A~A —

DIAGRAMMATIC LAYOUT OF WATER PURIFICATION PLANT
CITY OF CORNWALL

GORE & STORRIE LIMITED
CONSULTING ENGINEERS

TERMS OF REFERENCE

Appendix A-1

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive a package of available information on the plant from the MOE. Review the information provided and meet with the MOE staff to discuss the project.

2. Document the quality and quantity of raw and treated waters. Along with Work Task 3, send a progress report to the Project Committee at the conclusion of this work.

3. Define the present treatment processes and operating procedures. Along with Work Task 2, send a progress report to the Project Committee at the conclusion of this work.

4. Assess methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant. Along with Work Task 5, send a progress report to the Project Committee at the conclusion of this work.

5. Assess methods which would improve, if necessary, the disinfection practices of the plant, keeping in mind a desire to minimize the production of chlorinated by-products in the treated water. Along with Work Task 4, send a progress report to the Project Committee at the conclusion of this work.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal, with emphasis on particulate removal and a desire to minimize the production of chlorinated by-products. Meet with the Project Committee at the conclusion of this work to review the report information.

7. Prepare 7 copies of the draft report and submit to the Project Committee.

8. Review the Project Committee's comments and prepare 25 copies of the final report.

11/08/86

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 1

---

1. RECEIVE A PACKAGE OF AVAILABLE INFORMATION ON THE PLANT FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive a package of available information from the MOE concerning the plant.

(b) Review the information and otherwise prepare for a meeting to initiate work on the project, including preparation of a schedule of manpower and staff requirements.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule.

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2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS. ALONG WITH WORK TASK 3, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Tabulate the daily raw and treated water flows for the last three consecutive years.

(b) Document the methods of measuring the raw and treated water flow rates, and assess the validity of the records.

(c) Prepare a monthly summary of maximum, minimum, and average flows for the three years. Address any discrepancies which exist between raw and treated flow rates.

(d) Review and assess the monthly maximum, minimum, and average per capita flow for the three years. Compare the plant data with typical per capita flows for the local region.

(e) Document a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information. Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show_ corresponding sets of raw and treated water quality information. Document the source and methods used in determining all water quality information. Assess the validity of the data, comparing plant and outside laboratory data.

(f) Tabulate, for the last three consecutive years, where available, raw and treated water turbidity, residual aluminum, pH, and colour. Record other data, such as particle counting, suspended solids, and algae counting, which could reflect on particulate removal efficiency. These data should be used for assessment of the particulate removal efficiency of the plant. Document the source and methods used in determining all information. A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(g) Tabulate, for the last three consecutive years, the raw water bacterial test information at the plant. Also tabulate the corresponding treated water tests at the plant which register positive results. Document the source and methods used for all data provided. This information should be used to assess the effectiveness of the disinfection practices at the plant.

(h) Identify and recommend other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

(i) Submit a progress report to the Project Committee.

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3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. ALONG WITH WORK TASK 2, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSIONS OF THIS WORK.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings, of a reduced size, to document the general site layout and the interrelationship of major plant components. If not already available, prepare a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of the major plant components.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems.

(d) Tabulate the design parameters for all of the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire and must be confirmed and verified by field observations.

(e) Prepare a brief summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document and assess any reported problems in plant operations and/or in the distribution system related to water quality.

(g) Tabulate the daily average chemical dosages for the last three consecutive years. Document the methods used to evaluate chemical dosages and establish the validity of the dosage information provided.

With regard to disinfection, tabulate the dosages of chlorine and disinfection-related chemicals such as chlorine dioxide. In addition, provide corresponding data on disinfectant residuals in the plant, such as free and total chlorine residuals. Also, provide chlorine demand tests where available. Again, document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(h) Submit a progress report to the Project Committee.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 4

---

4. ASSESS METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT. ALONG WITH WORK TASK 5, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using information provided in Work Tasks 1 and 2, evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 FTU, which is the maximum acceptable concentration of the Ontario Drinking Water Objectives (Table 1, page 2, Ontario Ministry of the Environment, Revised 1983). It should, however, be recognized that it is desirable to strive for an operational level which is as low a turbidity level as is achievable.

(b) Conduct an evaluation of possible optimum performance alternatives, including jar testing of plant water samples.

(c) Evaluate the feasibility of optimum removals using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(d) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

(e) Submit a progress report to the Project Committee.

---

5. ASSESS METHODS WHICH WOULD IMPROVE, IF NECESSARY, THE DISINFECTION PRACTICES OF THE PLANT, KEEPING IN MIND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS IN THE TREATED WATER. ALONG WITH WORK TASK 4, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using the information provided in Work Tasks 1 and 2, evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives (Ontario Ministry of the Environment, Revised 1983).

(b) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(c) Evaluate the feasibility of the various alternatives using the existing plant capital works. Estimate the initial and final levels of chlorinated by-products for the various alternatives. Assess the relative merits of the alternatives.

(d) Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

(e) Submit a progress report to the Project Committee.

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6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL, WITH EMPHASIS ON PARTICULATE REMOVAL AND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS. MEET WITH THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK TO REVIEW THE REPORT INFORMATION.

Elements of Work

(a) It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost for each of the proposed modifications.

(b) Prepare a schedule for the list of modifications.

(c) Meet with the Project Committee at the plant site to review the proposed modifications.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 7

---

7. PREPARE 7 COPIES OF THE DRAFT REPORT AND SUBMIT TO THE PROJECT COMMITTEE.

Elements of Work

(a) The report must include all the information reported previously in the study. The information must be organized and presented in a logical and co-ordinated fashion.

A general table of contents will be provided for organizing the material in a manner consistent with other plant reports.

(b) Submit the draft report to the Project Committee for review.

(c) Prepare a separate letter report containing a recommendation(s) concerning the need for additional field testing to cover water quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

---

8. REVIEW THE PROJECT COMMITTEE'S COMMENTS AND PREPARE 25 COPIES OF THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implications of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit copies of the final reports to the MOE for distribution.

Appendix A-2
Terms of Reference
Wastewater Disposal Study

Purpose

To determine and document the present methods of disposal of wastewaters (filter backwash, clarifier sludge, screenings, etc.). If the wastewater is currently being discharged to the source water supply untreated, possible alternative methods for disposal should be suggested, along with estimated costs.

The consultant will:

1. Document the origin, amount and quality of sludge, screenings, etc. produced at the water treatment plant.

2. Document the volume and quality of filter backwash produced at the water treatment plant. Include at least 3 years of data, if available. If wastewater treatment exists at the plant the raw and treated qualities should be documented.

3. Document the present methods of disposal of the water plant wastewaters.

4. Identify likely alternative methods of treatment/disposal of wastewater along with associated cost estimates.

> Note: It is acknowledged that the 'level of effort' budget estimates will not permit an in-depth analysis of alternatives and associated costs that would normally be undertaken during preliminary conceptual design or an Environmental Study Report for such a facility. The level of effort applied to seek out and prepare cost estimates of alternatives should be in keeping with the assigned budget estimates.

APPENDIX "B"

Project No. 7-2007

to the agreement for Engineering Services covering preparation of

SCHEDULE "A" - Time Basis

Principals and Senior Officers ..... $94.00 per hour.

Senior Engineers and Specialists ... $67.00 per hour.

On a project which will involve any invoicing on the above mentioned or other time scale basis, the Consulting Engineer shall, before commencing work on the project, submit to the Director of Project Engineering concerned a list giving the names of the personnel whose time will be charged on an hourly, or other time scale basis showing their classifications and stating in each case their proposed duties and responsibilities in relation to the project. Unless the information has been submitted previously and approved, the list shall show the proposed invoicing rates. Where the fee will be based upon payroll cost, the list shall show the actual salary to be paid to the employee, exclusive of any adjustment for payroll burden or working time. The Consulting Engineer shall furnish the Director with information relating to the experience and qualifications of any of the personnel listed if so requested by the Director.

Under this Schedule, the Employer will pay the Consulting Engineer for the services of other staff (other than the classifications set out above) necessarily engaged on the project for the time such staff is so engaged on the following basis:

- Payroll cost multiplied by 2.5 for the first $8,000 of payroll cost relating to pre-design services or design work (except where design work is paid for mostly on a percentage fee basis per Schedule "B") for this project;

- Payroll cost multiplied by 2.0 for the balance of the payroll cost.

In this context, "payroll cost" means actual salary paid per hour multiplied by a "payroll burden factor" (C) to cover contributions made by the Consulting Engineer towards company and Canada pension plans, health and medical insurance, group life and disability insurance, unemployment insurance or worker's compensation and then multiplied by an "available working time factor" (D) to provide an allowance of 290 hours per annum for vacation time, statutory holidays, sick time and professional development time.

In the foregoing paragraph, "actual salary paid per hour" means current annual salary divided by 1950 or 2080 hours for a 37½ or 40 hour work week respectively.

The calculation of Factor C shall not include any amounts or allowances for any bonus or profit sharing scheme or any general or administrative expenses incurred by the Consulting Engineer.

The calculation of Factor D shall assume total times of 1950 and 2080 hours per annum for 37½ and 40 hour work weeks respectively. Deduction of the allowance of 290 hours referred to above gives available working times of 1660 and 1790 hours per annum respectively and values of Factor D equal to 1.1747 (i.e., $\frac{1950}{1660}$) and 1.1620 (i.e. $\frac{2080}{1790}$) respectively. In a case where neither of the above mentioned work weeks applies, the appropriate Factor D is to be calculated similarly.

The product of Factors C and D is known as Factor E, the Overall Payroll Burden Factor (see Ministry's current "PAYROLL BURDEN PERCENTAGE SUMMARY" form).

The following are further points relating to payroll burden matters:

(1) The overall payroll burden factor applicable shall be the figure as approved by the Ministry of the Environment for office staff or field staff as the case may be based upon the Consulting Engineer's latest completed fiscal year.

(2) The Consulting Engineer shall submit to the Director immediately after the execution of this Agreement, the Ministry of the Environment's current "PAYROLL BURDEN PERCENTAGE SUMMARY" form fully completed in respect of the Consulting Engineer's latest completed fiscal year, signed by an authorized signing officer of the Consulting Engineer and certified by the independent auditor who carried out the annual audit of the Consulting Engineer's accounts (unless the said form completed as required has previously been submitted to the Director).

(3) The Consulting Engineer shall submit a further "PAYROLL BURDEN PERCENTAGE SUMMARY" form within four months after the end of each further fiscal year so long as he shall continue to work under agreement with the Employer.

(4) The overall payroll burden factor derived from the form submitted in accordance with (3) above and approved by the Ministry of the Environment shall be used to adjust the Consulting Engineer's invoices to the Employer for time scale fees for the preceding fiscal year, unless the Consulting Engineer and the Director agree to waive such adjustment. The adjustment invoice shall be submitted to the Director within four months after the end of the fiscal year to which it relates, a separate invoice being submitted for each project.

(5) Invoices submitted by the Consulting Engineer for hourly or other time scale fees shall show the names, classification and time worked by each person involved. In the case of time scale fees, the relevant salary exclusive of payroll burden or adjustment for working time shall be shown against each name. Employee Code Nos. will only be accepted in lieu of employees' names if a key list has previously been furnished to the Director for the relevant Agreement showing employee names, classifications and Employee Nos.

If agreed upon by the Consulting Engineer and the Director of Project Engineering, Senior Engineers and Specialists may be paid for on the basis set out above for "other staff" provided that such basis does not produce a rate exceeding that set out above for Principals and Senior Officers.

In special cases, the Director may approve hourly rates in excess of the aforementioned rates for Principals and Senior Officers rendering individual services on special assignments, as requested or approved by the Director, for which they are eminently qualified and for which they require little or no staff assistance. In each such case, the rate shall be subject to negotiation, shall be approved in advance by the Director and shall not exceed 50% more than the hourly rate for Principals and Senior Officers on normal assignments.

Invoices submitted in accordance with this Schedule shall be accompanied by full details to the satisfaction of the Director.